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Engineering News-Record

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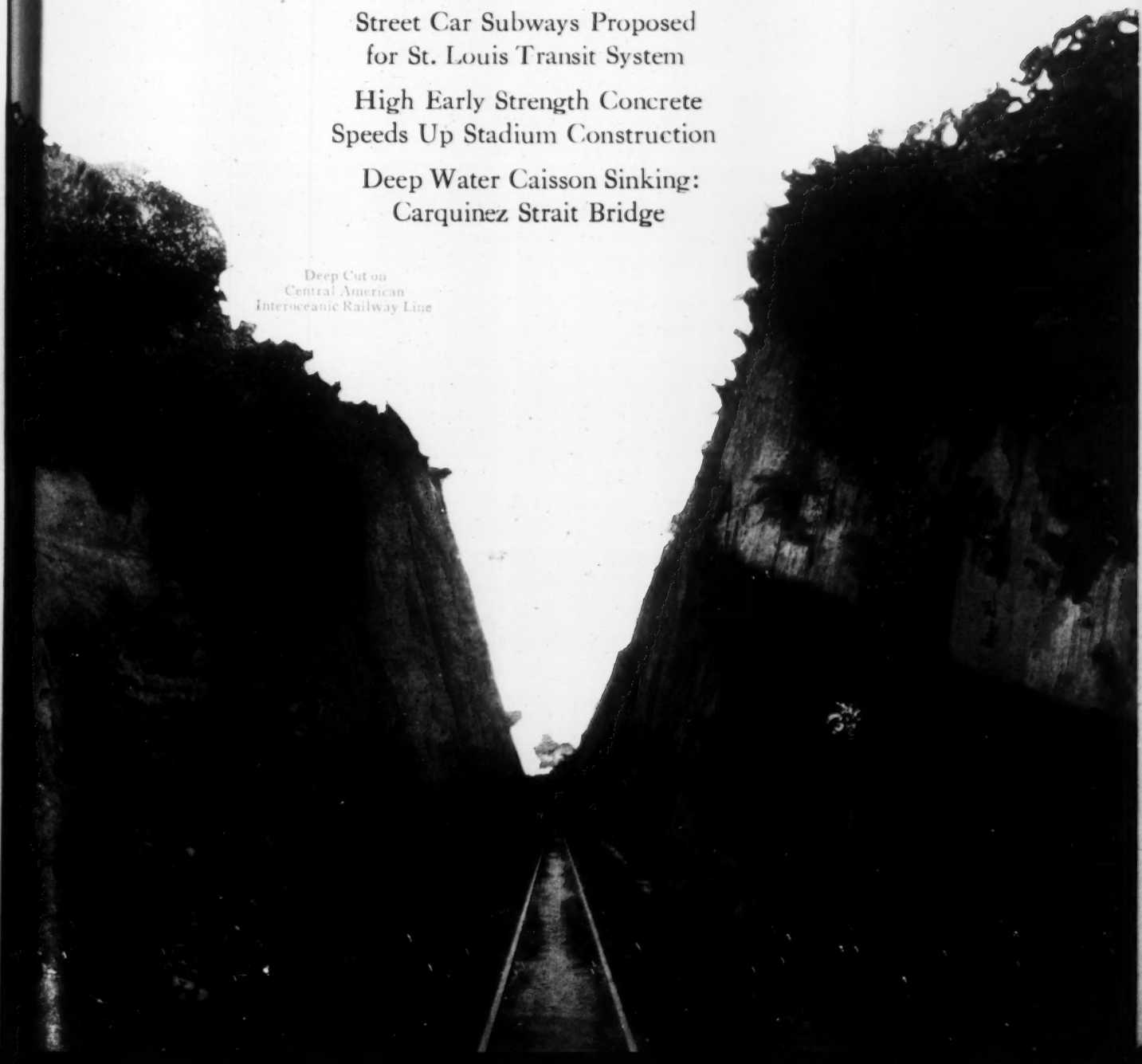
March 24, 1927

New Interoceanic Railway in Central America

Street Car Subways Proposed for St. Louis Transit System

High Early Strength Concrete Speeds Up Stadium Construction

Deep Water Caisson Sinking: Carquinez Strait Bridge



Deep Cut on Central American Interoceanic Railway Line

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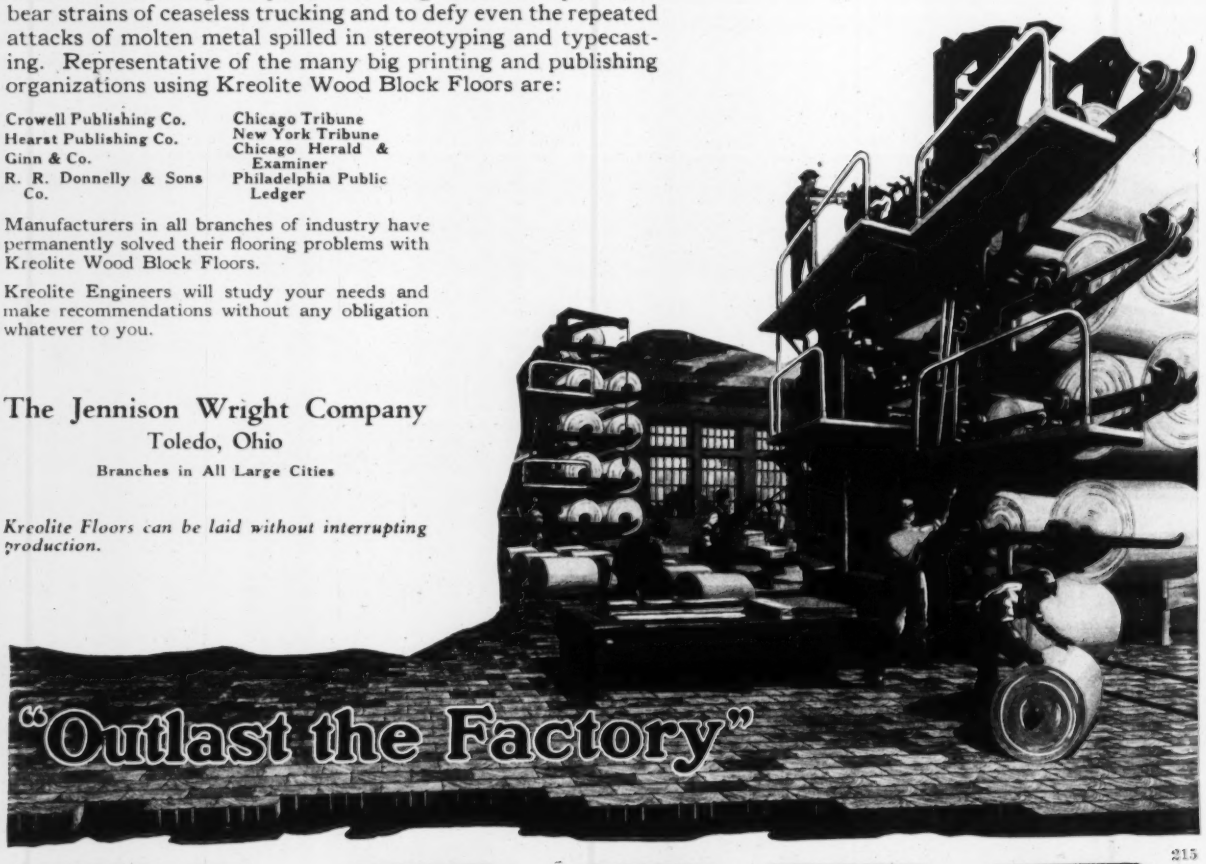

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FLOORS

WOOD BLOCK

A Consolidation of Engineering News, Engineering Record and The Contractor

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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Heart or Head

BY JUST what quirk of the mind the university professors at Columbia and Princeton have taken it upon themselves to propagandize against the European debt settlement is not quite clear. It is their undoubted right, but there are so many other important national and international issues on which they maintain a collective silence that their group action in this particular one looks as though there were some individual enthusiasm to which the professors fell easy followers. At any rate the Secretary of the Treasury in his letter to the Princeton faculty has set down one thought that all of those who are concerned with the debt settlement may ponder. There is great clamor among many that whatever be the economic justification for this country's stand on the debts this is a situation that transcends economics. We must be more than fair, we must be charitable, we must do something that will destroy the "Uncle Shylock" reputation that we have gained in Europe. "Countries," says Secretary Mellon, "no more than people can purchase affection." That is a good thing to remember when the heart clamors to govern the head in this debt settlement. Europe is in a state of mind regarding the United States. All the gestures in the world of reconciliation would be interpreted to our disadvantage. Were this country to offer even a complete cancellation of debt, would not the first and lasting reaction among those who are contending that we are Shylocks be that we must have up our sleeve some method whereby we benefit more by this cancellation than we do by debt collection?

A Great Contractor

THE death of W. O. Winston, a brief sketch of whose life is given in the news section of this issue, removes from contracting one of its most respected and inspiring personalities. A few weeks ago Mr. Winston recorded the fiftieth anniversary of the award of his first contract. At the time of his death he was still active in the affairs of the contracting firms which had been built up around his earnings and experience. It is given to but few contractors to survive for half a century the hazards of their business. By what necromancy did W. O. Winston accomplish this unusual record? In fifty years contracting has changed from "armstrong" methods employing many men and few machines to a highly technical task of co-ordinating complex machinery doing the work of many men under the handling of a few skilled mechanics. Construction materials, tools, methods, standards and restrictions have all been revolutionized. As a contractor W. O. Winston witnessed this revolution. But he did more than merely look on at the procession of events; always instead he was a marcher in the procession. It was this alertness of perception and action ten years ago when contracting sought to become articulate and unified by organization, which impelled the veteran constructor after he had completed almost the biblical span of life to throw his financial strength and personal prestige into the movement and labor as president and member of the Associated General Contractors as only a few members of that organization have labored. And to the last he worked, as his picture on another page shows him working, in association affairs. W. O. Winston was skilled in construction, his integrity was high, he unfailingly assumed responsibility and these qualities helped him, but his greatest asset was his faculty of greeting year by year the changing world of construction and keeping step with every movement which it made forward and upward.

Planning and Zoning Extended

HEREAFTER, any town in New York State no matter how rural, may go as far in planning and zoning as could reasonably be desired, provided it keeps within its own boundaries and clear of incorporated villages and cities. This means that the entire area of the State of New York is now subject to planning and zoning, if the local authorities see fit. So far as we know, New York State is far in the lead in this respect. The legislatures of some states have not yet authorized planning or zoning and others have restricted their grants to a few of their larger or at most to incorporated places. It is probable that for years to come scores of rural towns in New York State will make no use of the planning and zoning privileges granted to them, but the right to do so can work them no harm and may be of great benefit to many towns more populous or progressive. This possibility applies to scores of towns still mostly rural but with growing centers of population that have not attained and perhaps wish to avoid incorporation as villages. Certainly there is no good reason why any town, no matter how rural, should not be allowed to adopt and enforce an official plan and zoning regulations, subject to the right of appeal to the courts on the part of any one who considers himself aggrieved.

Deep Water Caisson Control

SKILL in holding foundation caissons steady in flotation against swift and contrary currents has about its highest exemplification in the operation described in this issue of building the pier pedestals of the Carquinez Strait bridge at San Francisco. Counting increased depth due to scour as the caissons approached bottom, the 40-ft. square structures had to be lowered through upward of 100 ft. of water by the necessarily deliberate process of building up and filling with concrete. Lateral fixity, the recognized essential of every such sinking operation, had to be particularly observed here because the caissons had to be set in groups of four and two units precisely spaced and placed with respect to each other. Altogether the conditions were hard and the

requirements were exacting. The plan adopted of using spud guides for the sinking caissons is as old as caisson sinking. Its distinction at Carquinez is that so great a length of spuds and such great and shifting lateral pressures against them had perhaps seldom before to be considered. In brief a system of spuds had to be devised which with a penetration of 20 ft. and a cantilever of 80 to 100 ft. would hold a floating caisson against current pressure of 49 to 96 lb. per square foot. These conditions made dependence on the cantilever resistance of the spuds with any practical system of integral bracing altogether hazardous. Exterior guying was necessary and this demanded guy anchorages in open water of great depth and with variable swift currents. The solution of the problem is from the constructor's viewpoint the outstanding feature of the Carquinez foundation work. Incidentally the manner of combatting the teredo pest commands attention. The procedure needs no separate description here but it is certainly not a negligible difficulty which besets the constructor where conditions render hazardous the temporary use of timber for more than three to six months unless rigid protective measures are taken.

A New Form of Government

SO COMPLICATED by politics is the present controversy in New York regarding the development of the state owned water powers that it may be unwise to make general deductions from the case. When a governor, of one party, is a potential candidate for the Presidency and his legislature is of the opposing party, economic issues may be expected to be subordinated in any difficulties between the two. But because power is so fast becoming a nationwide political issue—witness Muscle Shoals, Boulder Canyon, and the St. Lawrence—it is well to consider a few of the fundamentals as they are revealed in New York right now.

New York has a law for the leasing of water powers on state-owned lands or on the border rivers which is based on the Federal Water Power Act. By that law private companies are given a term lease on streams, pay a fee for the use of the water and sell the power at rates controlled by the State Public Service Commission. At the end of the term the state recovers the use of the water and may buy the privately built appurtenances which produce the power—at cost, less depreciation. Few leases have been issued under the law and no lease has yet run anywhere near the end of its term, so there is no precedent as to the interpretation of the recapture provision and very little to go on in any judgment of the regulation of rates under such a lease. But it is obvious that any such arrangement will continue to be subject to judicial interpretation.

Private interests have been very anxious to get such leases both on the St. Lawrence (which incidentally is academic at the present time and will continue to be so until the United States and Canada come to some agreement regarding that river) and in the Adirondacks and the Republican commission which administers the leasing system has been anxious to grant these leases, but the governor has been opposed. He started out some years ago with vague pronouncements which indicated a leaning toward a complete public development and ownership of the state-owned or controlled streams. He is gradually retreating from this position before the pressure of the obvious dangers of state ownership, dangers of inevitable extension first into distribution, then purchase of the primary private powers, both steam and electric, and finally complete ownership and operation of all the power business within the state. But he still maintains that the people will lose control of their rights in ownership of water powers under the existing system and, as a protective substitute, he has hit upon the idea of what he calls a Power Authority.

This Authority scheme is a new thing in government. It is having its first trial in the Port of New York Authority where its ultimate feasibility remains to be demonstrated. It is intended to be a cross between public and private ownership, retaining the best features of each. The Authority is a body appointed by the governor, confirmed by the senate, and thereafter operating as a private corporation to build and operate such structures and machines as are required for the purpose for which it is intended with money procured in the open market, the return of which is guaranteed by the proceeds of the business in which it is engaged. The state is in nowise responsible for the validity of such securities, but taxes are remitted upon them and because of their pseudo-official status they are expected to be sold—and were sold in the case of the New York Port Authority—at rates closely approximating those for public securities and considerably lower than for a private enterprise. It is the proposal of the governor, therefore, that such an Authority be established over all the public streams in New York State, that it proceed to negotiate with private interests for the sale of power and with the bankers for the sale of the securities, that once having raised the money and made such contracts it engage in the business of producing power which will be leased to the distributing companies.

It is contended that thereby the state will continue to keep control of the ownership of its potential power, the first cost of power will be cheaper because of the lower interest rates the Authority will have to pay, the people will continue to have the benefit of the superior operating ability and facility of the privately owned companies, the rates to the public will be definitely controlled by the contract for the sale of the power, and there will never be the possibility of a private monopoly swaying a rate control body and the ruling courts into an interpretation of value and rates therefrom which is inimicable to the people's interest.

Let us examine these claims. So far as the lower borrowing rate is concerned it rests on an entirely fallacious assumption, which amounts to economic deception. The government can borrow money cheaper than the private individual engaged in the same business because the security behind any government issue is the wealth of the community, and because there is the assumption that the people have some control over the expenditure of these moneys. Neither of these causes applies to the Authority. The government specifically disclaims responsibility for the securities of the Authority, which is a private corporation, the security for the return of whose funds lies entirely in the operation of the business in which it is engaged. Its directors, moreover, once appointed are not responsible to any one and can be removed only for high crimes and misdemeanors. They are far from being responsible to popular opinion or demand. The lower capital cost of an Authority conducted plant, and the lower rates which theoretically will result therefrom, mean that by false pretenses

money is being taken from the pocket of the investor and placed in the pocket of the user of the power.

It may be that certain revelations of the past year have shaken confidence in some public utility commissioners and particularly have cast a cloud over the righteous intention of a number of public utility operators. It may be that the courts continue to interpret value in a way which seems to be favorable to the private company, though this favor exists only in time of rising prices and when or if prices begin to fall the shoe will be on the other foot. But wherein does the Authority cure these evils? Will the individual who will represent the public interest as the operator of a power plant be more honest than the individual who now represents the public interest as the controller of the rates for private enterprise? Is more confidence to be put in the fairness of rates established by contract than rates established by regulation, in view of the history of the 5-cent fare in our street car systems? Why does not distrust of the court interpretation of rate regulation extend to distrust of the same court's interpretation of a public body's contract as to the sale of power, which itself is transmuted into rates. These are pertinent questions.

In short, the citizens of New York, and possibly in the future the citizens of other states, will have to decide whether this clever piece of machinery will do what is claimed for it. Will it insure cheap power and continued ownership; and if so will it do so any more effectively than the leasing system? They will have to decide whether the evils of public utility control are irremediable, and whether as a way out the tortuous alleys of government ownership should be explored. Is it better to bear those ills they have or to fly to others that they know not of? The halfway house offered by the Authority is appealing only superficially. Its Utopian combination of the advantages of private operation and public ownership does not look so sound when its implications are examined.

Can the Switch and Frog be Improved?

IN VIEW of the increasing study of railway track as an engineering structure it is pertinent to ask: "What of the switch and frog?" Is there any prospect of improvements which will eliminate weak points inherent in the present designs? Improvements have been made in details and in the materials used, but in type these devices remain unchanged, and represent an important item in the work and cost of track maintenance.

With the split switch, the long and thin tapering switch rail or point rail is the element which inventors have sought to improve upon, but as yet without practical success. Sliding rails, vertically moving rails, rails rotating on a longitudinal axis and elevated rails placed outside the track rails to engage the wheel treads have been designed and some of them have been put in service, but without affecting the universal use of the split switch.

The old and now obsolete stub switch had the advantage of a continuous line of solid rail, although this was offset by the crude connection at the sliding end, causing generally a wide gap at the joint which resulted in battering of the rails and wheels. A more serious objection was the inevitable derailment of a train trailing through on one track when the switch was set for the other track. Such accidents were numerous in the days of the stub switch, when signals and interlocking devices were in their early stages. Trains still trail through misplaced switches, but the danger of derailment is materially minimized with the split switch. Attempts were made to eliminate this danger by various forms of "safety" stub switches, but these had only limited application. Quite recently, a new stub switch has been designed, which is adapted to modern heavy track construction and aims to avoid the old trouble of open joint.

As to the ordinary rigid frog, all designs include the gap for wheel flanges, across which each wheel must pass, causing jar and shock which is felt more or less by passengers and which, with continual repetition, is injurious to both track and rolling equipment. It is true there is the spring-rail frog, giving a continuous rail for one track, but requiring each wheel on the other track to force the frog rail open against spring pressure. However, this type of frog is useful only at branch or siding turnouts where one track carries relatively light traffic. Some railways prohibit its use in main track, on the ground that it is not a desirable device to carry fast and heavy traffic. Mention may be made also of the flange frog, which is used rather extensively in yard and terminal layouts. This has the advantage of eliminating the usual pair of frog guard rails, the wheels being guided by their rims engaging flanges on the frog rails. It retains the open gap feature.

Several frog substitutes have been invented in which the turnout lead rail is elevated sufficiently to carry wheels over the unbroken maintrack rail, the wide gap at the latter rail being closed by a swinging device when the switch is set for the turnout. Like the spring-rail frog such devices are limited to light-traffic turnouts and have never passed the experimental stage.

A really promising device is a swing-rail frog having a movable rail interlocked with the switch mechanism and giving a continuous rail on the track for which the switch is set. Such a frog put in service a few years ago is said to have lasted much longer than ordinary frogs used at the same place, but unfortunately it was not developed commercially. Another and independent design of the same general type has been developed recently but has not yet been given actual trial. It is of interest to note that swing-rail frogs of simple design have been used successfully in mine tracks. Here the ends of the four 30-lb. rails rested on the opposite ends of a base plate, at the middle of which was pivoted a short length of rail connected to the switch, so as to line up on the track for which the switch was set. In this design, cars trailing through on the other track would be derailed, as at a stub switch, but the more elaborate devices for main-line tracks were designed to avoid this feature.

On the basis of the above summarized review, what answer can be given to the query already propounded? Frankly, it may be said that there is not in sight any practical development along new lines. Of the two, the frog is the more promising, since at least one substitute device has been found effective in actual use. Such developments are much to be desired and there is an open field for new designs and inventions. In the meantime, there is still opportunity for further improvement in the present types of switches and frogs to increase their efficiency, minimize their objectionable features and reduce the cost of maintenance in track.

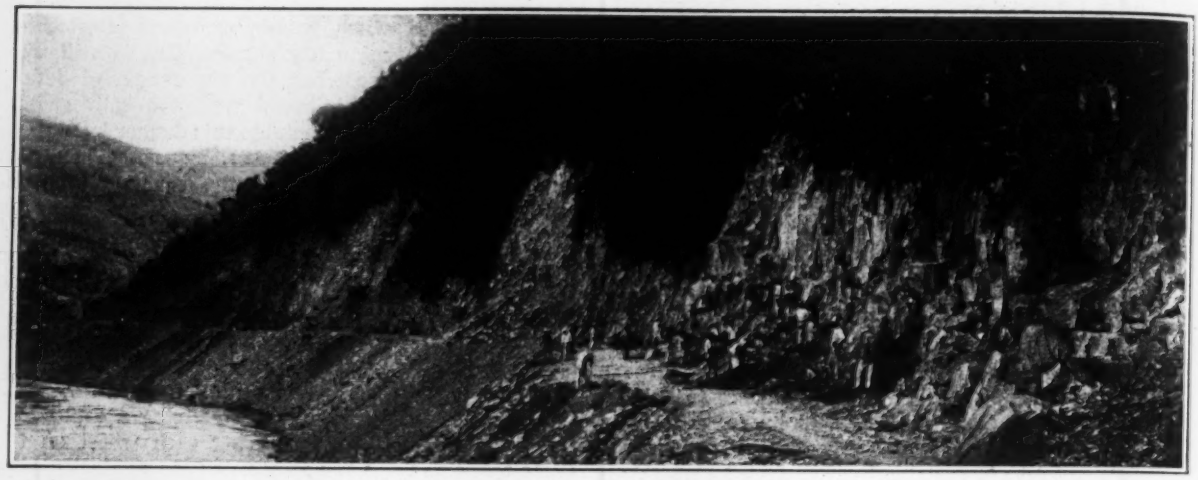


FIG. 1—MANUAL LABOR USED EVEN IN HEAVY ROCK WORK

A New Interoceanic Railway in Central America

American Owners, Engineers and Contractors—Hand Labor on Heavy Grading—Torrential Streams—River Diverted and Railway Laid in Old Channel

A NEW Central American interoceanic railway 425 miles long, between the Pacific port of La Union, Salvador, and the Atlantic port of Puerto Barrios, Guatemala, is expected to be established early next year by the International Railways of Central America, which is a United States concern. This will be accomplished with the completion of two links now

FIG. 2—NEW INTEROCEANIC RAILWAY: SALVADOR AND GUATEMALA

under construction from Soyapango (near the city of San Salvador) to Texistepeque, 62 miles, and from Santa Ana to Zacapa, Guatemala, 105 miles. From Zacapa to the Atlantic it will use 100 miles of the present interoceanic line in Guatemala from San Jose to Puerto Barrios.

Construction of this new route will put Salvador within a 12-hour instead of a four-day trip to the Atlantic and will give it an Atlantic outlet for its coffee, which is the country's most important product. The present and new lines, all of 3-ft. gage, are shown in Fig. 2, which also shows the English-owned railway from San Salvador to Santa Ana and the Pacific port of Acajutla. From both ends of the mountainous section, whose profile is given in Fig. 2, the country is practically level to the coasts.

The International Railways of Central America, of which Minor C. Keith is president, is said to constitute the largest American-owned railway enterprise outside of the United States. Under a concession from Guatemala, in 1905, it acquired the line built by the government from Puerto Barrios to El Rancho, 136 miles, through generally easy country. In 1908, it completed the 61-mile extension to Guatemala City, using 3 per cent grades in climbing through mountainous country

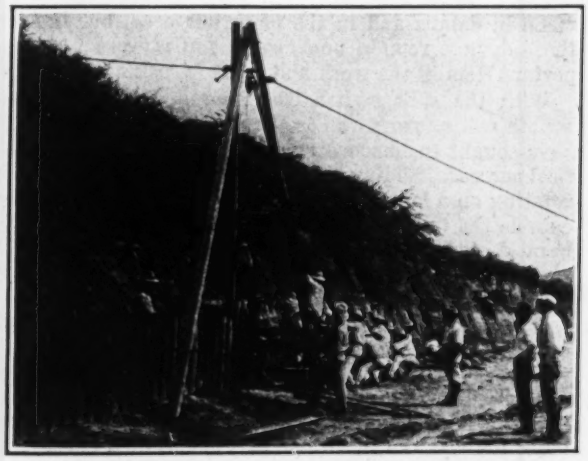


FIG. 3—DRIVING SHEETPILES BY HAND

from 300 ft. to an elevation of 5,000 ft. above sea level. In 1912 it purchased the Guatemala Central R.R., from Guatemala City to San José, 138 miles, thus completing

FIG. 4—HAND LABOR ON HEAVY GRADING WHERE GRADE IS DIFFICULT TO ATTAIN

an interoceanic line having a total length of 335 miles. A line from Esquintala, near Santa Maria, to connect with the Pan-American R.R. of Mexico, 128 miles, was

FIG. 5—DEEP CUT IN TALPETATE CONGLOMERATE

completed in 1915. In 1922, the company completed a line from the Pacific port of La Union to San Salvador, 157 miles. This line now extends beyond La Union to Cucuta, where deeper water and a modern wharf are available. Both these ports are on the Bay of Fonseca, in which the United States government has the right, by treaty with Nicaragua, to establish a naval base.

In 1922, therefore, the International Railways had 458 miles in Guatemala and 157 miles in Salvador, separated by 175 miles of broken and rugged country which had not even a cart road. To connect these two systems, a line from Zacapa to San Salvador was commenced in 1924 from the northern end and in 1925 from the southern end. During 1925 and 1926 about 6,000 men were at work on the construction. There are five tunnels within 50 miles of Zacapa, but no large streams are crossed, although all the streams are troublesome on account of periodical floods in the rainy season. Bridges are designed for Cooper's E-50 loading. The maximum grades are 2 per cent northbound and 2.6 per cent southbound, with a maximum curvature of 18 deg. The track has 60-lb. rails on creosoted pine ties imported from this country and will be ballasted with stone and gravel.

Much of the heavy grading is in the conglomerate known as "talpetate," or else in hard rock. For cuts in the former material (see Fig. 5) the slopes are made about 1 on 1 or as steep as they will stand, in order to prevent erosion by the torrential rains. In places the line follows along the banks of streams, and flood conditions make it necessary to protect the slopes by wood or steel sheetpiling or by masonry foot walls. Hand driving of steel sheetpiles for this purpose is shown in

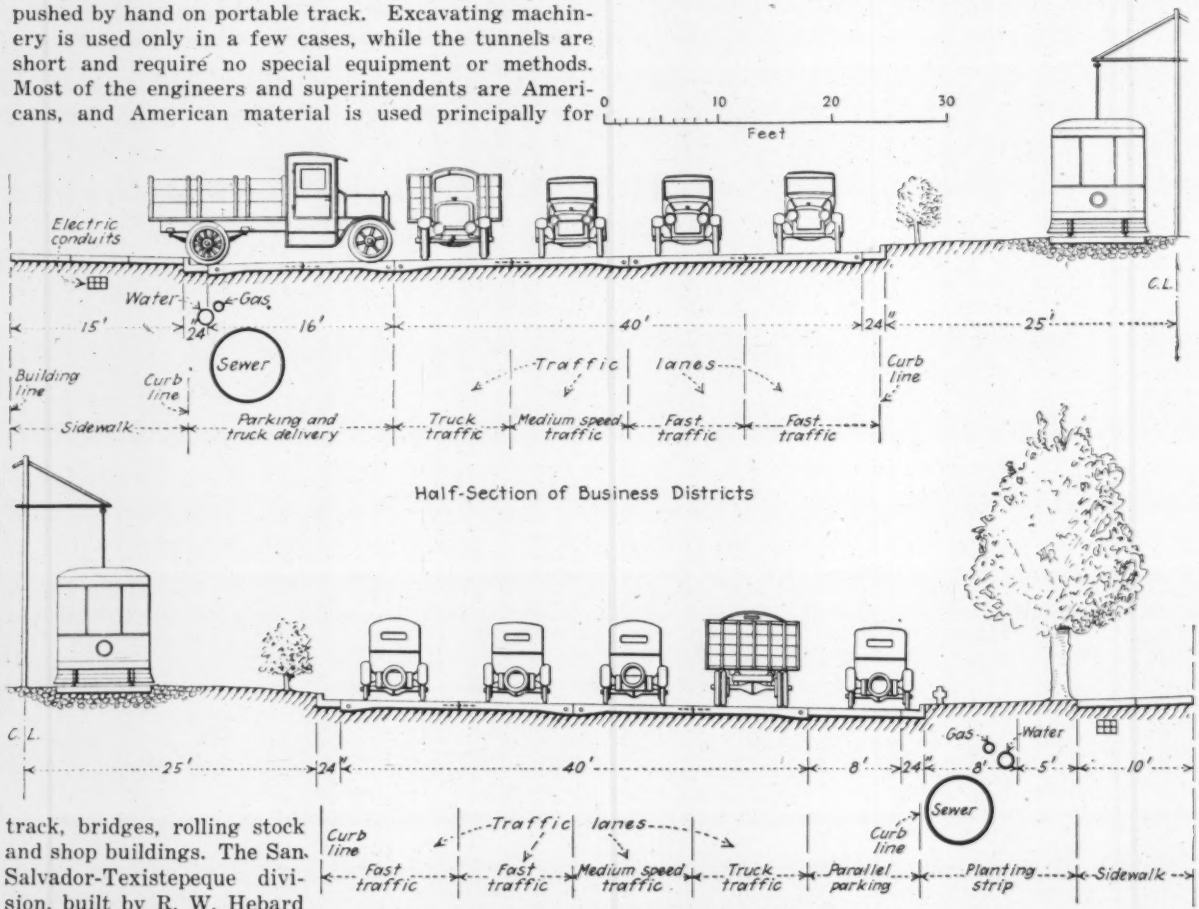
Fig. 3. Most of the masonry for walls and bridge abutments is of rubble stone laid in cement mortar, though concrete is used in some cases. At one point on the Sucio River, a bend in the river was taken out by cutting a diversion channel through the narrow dam-like ridge, the old channel being then utilized for the roadbed. Most of the bridges are short truss or plate girder spans, but the Lempa River is crossed by five truss spans. Timber trestles are not used.

As labor is plentiful and low priced, with an average daily wage equivalent to 75 cents U. S. money, most of the grading is done by hand, as shown in Fig. 4. On heavy work, material is handled by small dump cars pushed by hand on portable track. Excavating machinery is used only in a few cases, while the tunnels are short and require no special equipment or methods. Most of the engineers and superintendents are Americans, and American material is used principally for track, bridges, rolling stock and shop buildings. The San Salvador-Texistepeque division, built by R. W. Hebard & Co., New York, was completed in November, 1926. The Zacapa-Santa Ana division, and the 31-mile Ahuachapan branch into a large coffee-growing district, are being built by Keilhauer & Rodezno, of Guatemala, and will be completed early in 1928. S. F. Shaw is chief engineer of construction for the International Railways of Central America.

In addition to this new work, there have been large expenditures in recent years on curve and grade reduction, ballasting and heavier rails, while modern shops have been erected at both Guatemala City and San Salvador. A coast line from Ahuachapan to Santa Maria is projected, and it is proposed also to extend the La Union line across Honduras to connect with the Nicaragua railways and thence to a connection with the railways of Costa Rica, thus linking up these five Central-American republics.

Chicago Superhighway Design Wins Prize

THE design for a heavy traffic highway, shown in the accompanying drawing, won the first prize, $1,000, offered by the Metropolitan Super-Highway Association, Chicago, Ill., in a competition of designs for the 200-ft. highways which are proposed to serve the Chicago metropolitan area. It was submitted by R. E. Toms, district engineer, U. S. Bureau of Public Roads, Montgomery, Ala. A special feature of the plan is that it provides for progressive construction, beginning with a single 20-ft. roadway on one side of the right-of-way. This would be followed by a similar roadway on the other side, both of these being widened by additional 20-ft. paved strips as required and the central space being utilized eventually for a rapid-transit line. The drawing shows the ultimate stage of construction of the design.



PRIZE WINNING DESIGN FOR CHICAGO SUPERHIGHWAYS

The drawing shows the ultimate stage of construction of the design.

These highways are to have a 200-ft. right-of-way, with provision for sidewalks, parkways, public utility services accessible without disturbing traffic, parking space, separate lanes for fast and slow traffic, and rapid-transit electric lines. There will be no grade crossings.

A comparison of this design with that of the Woodward Ave. superhighway described in *Engineering News-Record*, March 4, 1926, p. 350, is interesting.

Clearing a Raft of Drift Timber from Colorado River in Texas

Drag-Line Dredges, Tractors and Power Winches Remove 14-Mile Obstruction of Logs and Silt to Prevent Floods

By J. P. Markham
Chief Engineer, Wharton County Conservation and Reclamation District, Wharton, Texas

An accumulation of logs and drift timber, known as a "raft" from its original resemblance to a floating raft, which has been an obstruction to the Colorado River, in Texas, for more than a hundred years is now being removed to open the channel. In "Rise, Progress and Prospects of Texas," by Wm. Kennedy, published by R. Hastings, London, England, in 1841, is a report (Vol. 1, page 44) by W. D. Wallach, C.E., made to the board of aldermen of Matagorda, in July, 1839, which says: "About ten miles above its (the Colorado River) mouth is a raft formed of drifted timber, which obstructs navigation." There is also filed in the District Court of Colorado County, Texas, a bill of lading dated 1857 for a shipment of cotton by boat to Galveston, which recites that the cargo is to be delivered "at the head of the raft above Matagorda."

As the raft was built up at its upper end, its lower end was rotting and washing away. It is my theory that the raft was never more than five or six miles long until about 1902, when the rice-growing interests of Matagorda County capitalized the fact that the raft

FIG. 1—TYPICAL VIEW ON OLD CHANNEL
Standing timber cut but no other work done on the obstructive "raft."

had materially raised the level of the water. They developed canals by which the water was taken above the raft, and distributed throughout the rice fields by gravity. To maintain the raft, these interests used cables and dams with such effect that the raft extended for a distance of about 14 miles. The drifted timbers are of all sizes, some as large as 4 ft. in diameter and 50 ft. long. These logs, together with the brush and silt brought down by the current, have filled the original channel of the river, which was 25 to 30 ft. deep and about 225 ft. wide as a minimum. In some places there is a six- to ten-year growth of timber in what had been the river bed. No water could pass except what would filter through the raft or flow over it at flood times.

This river is one of the heaviest silt-bearing streams in the country, and the first effect of the floods was to kill the original growth of timber and to deposit on the surface of the bank 10 to 14 ft. of silt, on which there is now a thick growth of willow, sycamore and cottonwood. At one point the bank is 10 ft. higher than it was in 1922. The growing raft caused an overflow of the land on each side of the river, for a distance of two to three miles to the prairie lands. As

FIG. 2—PULLING LOGS FROM RAFT
Tractors and power winches being used after getting some water in the channel.

the land became more valuable and more of it became subject to overflow, it was realized that something would have to be done. The town of Bay City was twice inundated, and the city of Wharton, 62 miles above the mouth of the river, could see that it would be flooded after a time.

As the cost of remedy was too great for any local interests, the Texas legislature remitted the taxes of the counties of Matagorda and Wharton for a period of 25 years. This grant was capitalized by bond issues amounting to $650,000 for Matagorda County and $600,000 for Wharton County. The latter was to remove the raft and the former was to see that the timber when turned loose would go out into the Gulf. At this time I became interested in the Wharton County part of the program. Reports previously made by various engineers, including several by the U. S. Engineer Department, advocated a bypass or new channel. My investigation demonstrated that the efficiency of this would be questionable, and that its cost would be prohibitive. In addition, any plan for work outside of the original river would antagonize the rice-growing interests and might lead to litigation, while work in the natural river bed would not have this objection.

By persistent and careful sounding with an iron-shod pole, I found that after penetrating from 10 to 12 ft. it encountered no more logs, but went through soft silt for several feet. In seeking the reason for this condition I found that at the head of the raft there was only from 4 to 6 ft. of water, over soft silt 18 to 20 ft. deep. There was a very gradual increasing depth of water upstream, it being necessary to go a mile above the raft to get water 20 ft. deep. This condition showed that the raft was not a solid mass of drift to the bottom of the original river, as had been supposed, but that it was a series of wedge-shaped masses of logs deposited on a bed of silt formed on each occasion at the head of the raft. It must be remembered that the head

remained stationary sometimes for as long as two years, and at other times it would build up two miles in one year. In fact, during the year beginning Sept. 3, 1925, when the improvement contract was let, it did build up a distance of 1½ miles. This investigation convinced me that the river could be opened successfully with the available money.

My plan was to begin at the lower end of the raft, and with tractors, powerful winches and dynamite, to cut a channel upstream through the raft so as to get a good flow of water through its entire length; then to feed the débris of the raft to this current. After some objections, this method was undertaken, and was soon recognized as feasible. Bids were advertised for in August, 1925, but considerable trouble was had in getting contractors to bid, because there was no precedent by which they could be guided for work of this kind. It was impossible to give any accurate ideas as to quantities, so that a lump-sum bid was necessary. Several contractors from different parts of the country looked at the situation, but most of them declined to bid and $2,000,000 was mentioned as a minimum sum. However, Howard Kenyon, head of the Howard Kenyon Dredging Co., Houston, Texas, was impressed with the possibilities and after an investigation by B. G. Warner, one of his engineers, he decided that it could be done. The company made a bid of $485,000 and was awarded the contract to deliver a river channel 200 ft. wide and 20 ft. deep in three years from Sept. 3, 1925. Mr. Kenyon makes the following statement:

"The contract was awarded more than a year ago, and every development since that time has confirmed the conclusions of the chief engineer and demonstrated the fact that the work was not so hazardous as to make it unwise to accept it on a fixed bid. The difficulties have proved to be not as great as the chief engineer or I expected they would be and the river will be opened on time."

There is now an open channel through the entire length of the raft, from 50 to 100 ft. wide and 6 to 30 ft. deep. The current carries off all débris, except some timbers that will not float, such as live oak or green cottonwood. These, as well as logs that are too long or too crooked, are hauled out by the tractors, which are equipped with winches and can develop sufficient power to part ¾-in. wire cables.

Four tractors were used for the initial work of opening the channel through the raft; in addition we have two 1½-yd. dragline dredges on barges and will increase this number if advisable. These dredges simply disturb or agitate the bottom of the channel, lifting out and placing on the bank such logs as are considered dangerous, but more than 90 per cent of both débris and silt is carried away by the current. To appreciate the effect of this current, bear in mind that the elevation of the water at the head of the raft was 34 ft. higher than at the lower end, 14 miles distant. We are careful to conserve as much of this head as we can, consistent with the progress of the work. In fact, it has been one of my greatest problems to guard against making too large a channel at first and thereby losing this head of water. We do not expect any difficulty in obtaining the contract width or depth after these dredges go through, as with the obstruction removed, the channel quickly washes out to the bottom of the river. When this depth is obtained, the banks on one or both sides are undermined by the swift current and quickly cave or slide to the required width. The lower five miles of this contract is now from 2 to 16 ft. below the contract depth, and for more than half of this distance we have a greater width than the contract requires. The stage of the river does not hurt or hinder our work. At flood stage it washes out and deepens the channel, while at low stage we can work in the river to better auvantage with our dredges. In the earlier stages of the work, including cleaning the river of standing timber, we used as many as 125 men, but our present force is from 20 to 40 men.

Soft Ground Tunneling Methods for Small Sewer

Two Methods of Tunneling Compared—Clay and Wet Gravel Penetrated—Cant and Shield Method Found Superior

RECENT completion of a sewer nearly a mile long mostly in tunnel at Akron, Ohio, affords a comparison of progress by three different construction methods. Approximately 538 ft. of the sewer had been built by an old contract in 1923 and the work then abandoned. The second contract was let in December, 1923, and it is to this part of the work that the present account relates. Fig. 1 is a plan and profile of the sewer and Fig. 2 shows sections.

The new contractor erected an air compressor plant at Hawkins Ave. and Fairfax Road, Fig. 1, started with the cap and leg method indicated in Fig. 2, and worked from the old shaft at manhole 4 + 53. The sewer was to be 48 in. in diameter, but by request of the contractor, to provide additional headroom, the vertical diameter was increased to 60 in. A portion of the end of the old sewer was enlarged for air locks; and as it was impossible to hold the air, it became necessary to repoint the old brick masonry and to grout outside the original sewer as far back as the shaft, a distance of 85 ft.

A new shaft was opened in the intersection of Hawkins Ave. and Fairfax Road, at manhole station 9 + 03, where it was intended to start using a shield and the section shown in Fig. 2, but as the muckers approached this shaft it was increasingly difficult to maintain enough air pressure to offset that due to the water. The shaft was therefore sealed and partly backfilled and a new shaft was sunk by caisson at station 12 + 53, which made it necessary to continue with the cap and leg method for another 350 ft.

This shaft was excavated and timbered to a depth of 20 ft. and the caisson was started by using a ⅜-in. steel shell, 12 ft. in diameter and made in sections 5 ft. long with flanged ends. A 13-in. brick wall resting on the bracketed cutting edge was built inside and the shell lowered by its own weight. When considerable ground water was encountered the shell was capped with a concrete slab through which was placed a locking manhole in two sections 48 and 36 in. in diameter, 16 ft. long. Additional sections of shell were bolted on, the brick liner built and the excavation continued under air until the cutting edge was about 4 ft. below the invert of the proposed sewer.

The tunnel was then constructed through and beyond the caisson and a new air chamber 70 ft. long was built large enough to permit the passage of the shield. The cap and locking manhole were then removed and the

COMPARATIVE PROGRESS BY THREE METHODS OF SEWER CONSTRUCTION

	Mucking including Timbering Feet per 8 hours		Masonry Feet per 8 hours	
	Average	Maximum	Average	Maximum
Cap and leg....	2.5	4.2	10.5	15.4
Cant and shield	7.0	14.3	11.8	24.2
	2.7		12.8	

shield was lowered and finally nosed into the tunnel. It was uneventfully jacked to station 22 + 90 (through an undulating shallow lens of blue clay, which was over- and underlain with water-bearing sand), and the tunneling was then stopped until a section just back of this point could be enlarged for a new air chamber. The air plant was then dismantled and set up at Alton St. and Hawkins Ave., while the shaft at manhole station 21 + 87 was being excavated.

Tunneling was later continued with the shield and air until station 43 + 65 was reached where the depth was 33 ft. and the overhead materials were sand and gravel. The last 65 ft. of this stretch required 28 days and as it was impracticable due to the loss of air to maintain enough pressure to hold back the water, the heading was frequently lost. As a result, the shield was forced off line and grade and after a number of futile attempts to correct the alignment, it was bulkheaded and abandoned. From this point to the end of the contract the sewer was completed in open cut. In general, in order to cut down the length of haul inside the tunnel, the shield was pushed far enough ahead of a proposed manhole to permit the installation of a new locking chamber, after which the excavation was made for the manhole and the materials removed and lowered through the near shaft.

The external diameter of the shield was 6 ft. 9 in. and the overall length was 10 ft. The shell plate was stiffened by a circular girder inside and had a bracketed cutting edge which served as a hood and extended around two-thirds of the circumference. The liner consisting of thirteen hardwood cants, 6 in. thick, used to hold the excavation and take the thrust of the jacks,

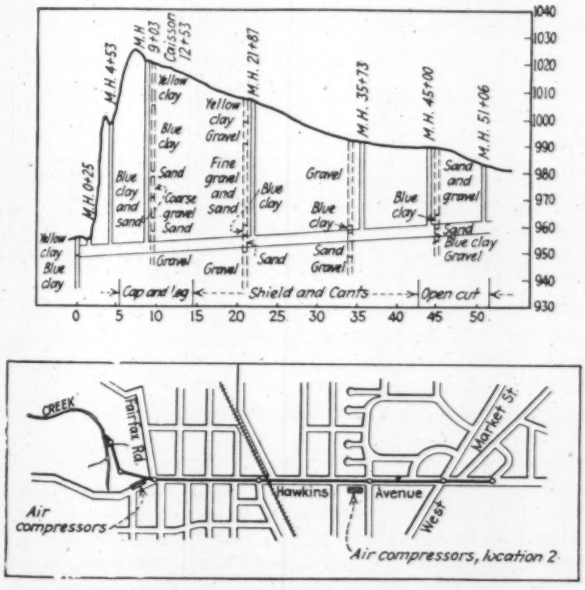


FIG. 1—PLAN AND PROFILE OF HAWKINS AVE. SEWER TUNNEL, AKRON, OHIO

was assembled within the tailpiece which was 36 in in length.

The mining and mucking organizations were about the same with both tunneling methods and the job was worked 24 hours a day, in shifts of 8 hours each. The muckers usually worked a sufficient number of consecutive shifts to provide headway for one shift of masons.

The sewer in open cut was started with four sets of sheeting and towards the end only two sets were used.

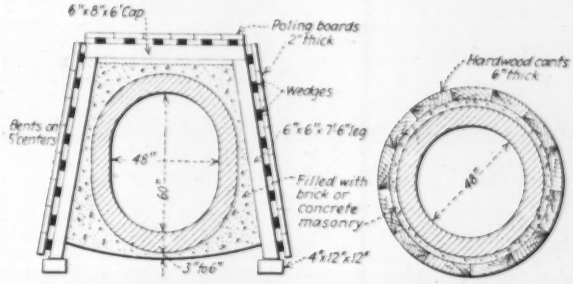


FIG. 2—SECTIONS OF TUNNEL BUILT BY TWO METHODS

The men worked one 10-hour shift daily and the bricklayers were employed when required. The progress for open cut, shown in the table, was converted from 10 to 8 hours for direct comparison with the other methods.

The sewer was built by the T. E. McShaffrey Construction Co., a local contractor, under the supervision of J. E. Root, sewerage engineer, and Charles Lange, construction engineer for the city of Akron. The writer was engaged on the design and preparation of plans and specifications.

International Strain-Gage Competition Not Decisive

ACCORDING to announcement of the Deutsche Reichsbahn Gesellschaft (German Railway Co.), Berlin, the international competition for strain gages and vibration measuring instruments suitable for use on bridges was decided late in December. The jury came to the conclusion that none of the devices submitted fulfilled the requirements specified, and it was decided to award no prizes. However, money awards amounting to 20,000 M. ($5,000) were made to the competitors who had submitted the best instruments:

Rendel, Tritton & Palmer, London, for the Fereday-Palmer strain recorder, 4,000 M.; Lehmann & Michels, Hamburg, for the Geiger strain recorder, 3,000 M.; H. Honneger, Corcelles, Switzerland, for Meyer strain recorder, 3,000 M.; Lehmann & Michels, Hamburg, for Geiger vibration recorder, 3,000 M.; H. Maihak, Hamburg, vibration recorder, 3,000 M.; Dr. Reutlinger, Darmstadt, combined strain and vibration recorder, 1,500 M.; H. Sürig, Hannover, for a combined strain and vibration recorder, 1,500 M.; Trüb, Taüber & Co., Zürich, de Quervain vibration recorder, 1,000 M.

The jury of awards carried on laboratory tests with a shaking table, and field tests on a steel truss bridge under electric locomotive loading and under a single-axle load. It examined the manner of recording, weather protection, adaptability to distant indications, internal friction, resonance, accuracy of record, adaptability to various forms of structural member, and ease of manipulation. The jury consisted of five well-known engineers: Dr. Zimmermann, Dr. Gehler, Dr. Saller, and Messrs. Buhler and Hulsenkamp.

Charts Check Costs and Progress in Dam Building

Methods Proved in Ship Yards and Building Work Applied to Concrete Dam Construction for Power Development

By Dan Patch
Stoneham, Mass.

THE methods here described are developed from similar methods used by the writer years back in the ship yards and adapted in 1915 to building construction (*Engineering News-Record*, Oct. 11, 1917, p. 684). A dam is different, however, from a building, with its repetition of operations, and there was some doubt as to the efficacy of these methods for keeping those interested informed as to what was happening on such diversified work. It was decided, however, to try them out in connection with a recent undertaking of the Morton C. Tuttle Co. (*Engineering News-Record*, Aug. 26, 1926, p. 326). The theory on which the charts were made is that labor records are better indicators of progress than combined labor and material records.

In order to develop a chart which would show the weighted progress of all the various items involved, each item of labor cost was assigned to a time period which fitted the main program. The money allowance for each of these items was then distributed throughout its time period as it was estimated it would be spent. The estimated amount set into weekly space was not the weekly expenditure but the cumulative amount to that date, so that the figures would form a scale against which actual expenditures could be plotted as a horizontal line. The item distributions were summed up to make the cumulative labor budget line of the chart shown in Fig. 1. By deducting the total through each week from the total through the succeeding week the weekly payroll was estimated.

To follow the performance of the job against the plan a master chart was prepared each week, Fig. 2. Each item space was divided into three horizontal belts: the upper one for the estimated expenditures, the middle for the total cost to date of labor expended, and the lower for entering the money's worth of work done. This, in case of items on which engineer's quantity estimates were available, was computed by multiplying the quantity done by the unit at which it was estimated. For other items, estimates of the amount of work accomplished were made by foremen in charge or by the superintendent. Something over a hundred items were thus charted. Items of extra work were carried on the chart at their actual cost.

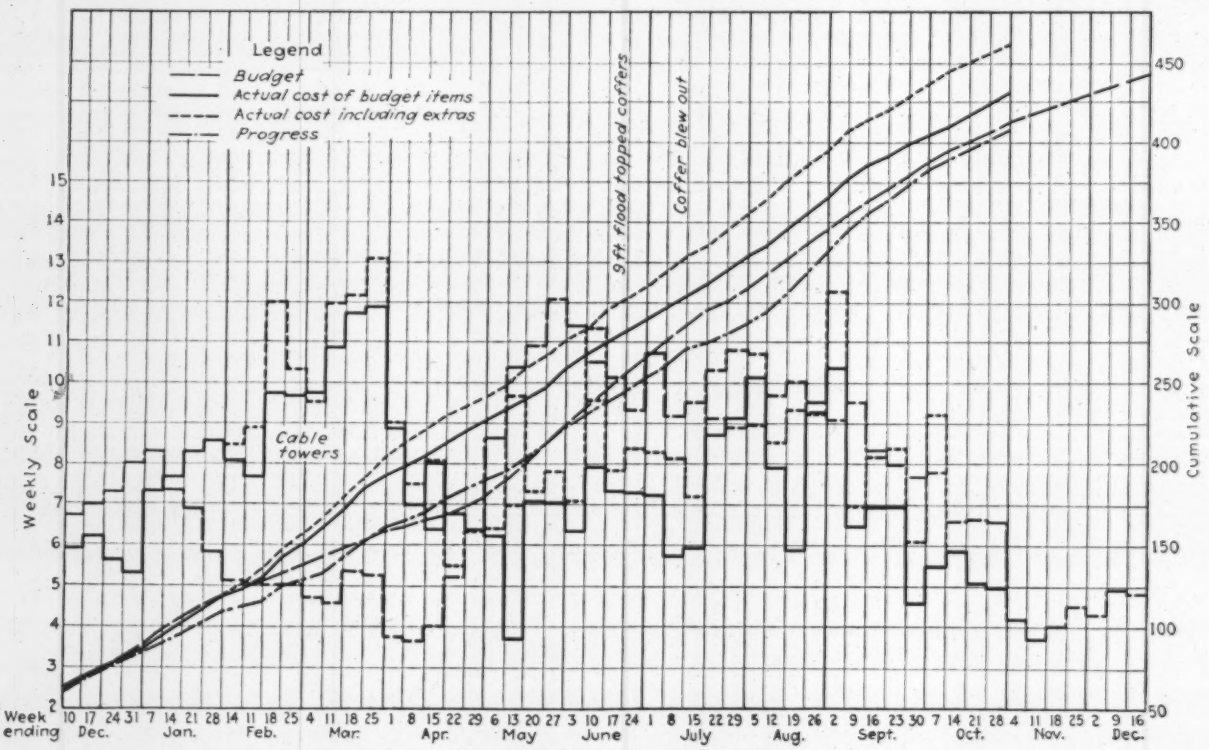


FIG. 1—LABOR BUDGET CHART FOR CONCRETE DAM

Each week the total payroll to date was plotted on the labor budget chart, and the trend of this roll shown by a heavy dotted line. The cost of extra work was then deducted determining the amount expended on items of work included in the budget. This amount was checked with the sum of the entries in the middle belts of such items on the master chart and plotted on the labor budget chart as a heavy solid line.

The total of the entries in the lower belt of the master chart was plotted on the labor budget chart as a heavy dot and dash line. The actual weekly payrolls were plotted as horizontal lines across the weekly space. Only the labor budget chart was sent weekly to the executives. From this as a summary chart the owners and the home executives of the construction company could each week tell the relation of actual to

proposed expenditures and of actual to proposed progress.

The horizontal distance from the end of the dot and dash line to the budget line, read on the weekly scale, indicated the time ahead of schedule if the dot and dash line was at the left, and behind schedule if at the right. The vertical distance from the end of the dot and dash line to the heavy solid line, read in differences on the cumulative scale, indicated the amount of money saved on the estimate if the solid line were below the dot and dash line and the over-run if above. The vertical difference from the end of the heavy solid line to the dotted line showed the amount spent for extras.

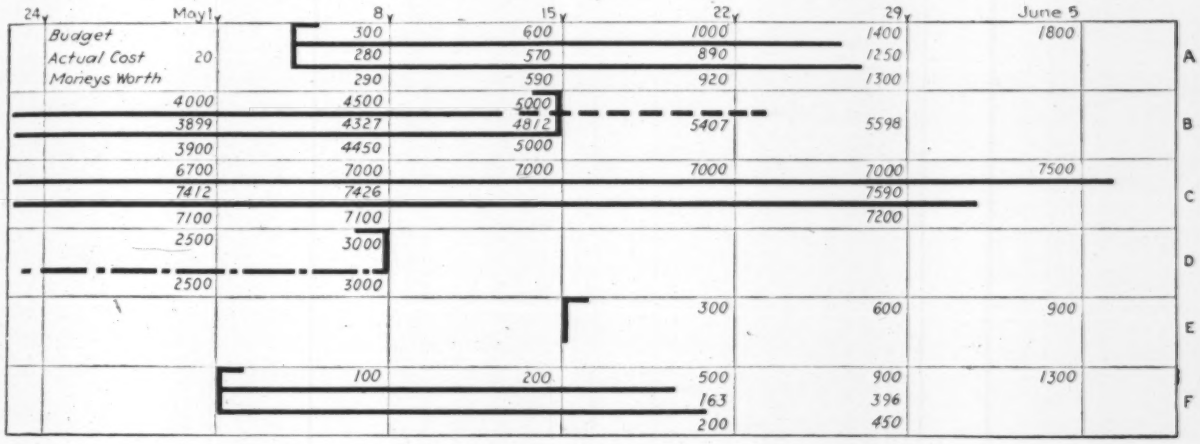


FIG. 2—SECTION OF MASTER CHART OF COSTS AND PROGRESS

The record seems quite remarkable. It will be noted that the job payroll started in late January to run heavier than estimated. The fact that there was at the same time a wider spread between the heavy solid line and the dot and dash line than between the solid line and the dotted line indicated clearly that the extra payroll was due to over-runs on the estimates. These indications would have been alarming had not the master chart shown that they were in items of plant erection which would not continue throughout the job. The rather startling pinnacles on the actual weekly roll record are due to the fact that certain operations were handled on the owner's payroll and transferred to the job accounts at intervals of several weeks through journal entries. Had these charges been recorded weekly, the weekly rolls would have been nearer to those estimated.

The effect of the June flood and the coffer blow-out are clearly seen in the bending down of the progress line through July and early August, but immediately after is the indication of the gang fighting back to overcome this delay, and the saving of money on some items bringing cost and money's worth closer together.

While the large master charts were not mailed to all the parties interested in the summary chart, from their point of view being only the mass of detail back of the picture, they were of considerable interest to the "man behind the gun" as they indicated very clearly what items were causing either time or cost changes from the schedule.

A small arrowhead was placed at the date to which the chart was entered and this vertical line became the basis of judging progress. An angle with the toe pointing to the right indicated the date on which an item was supposed to start and one with toe to left the date on which an item was to be completed.

A discussion of each of the hypothetical items in Fig. 2 will make clear the details of the chart.

Item A—The fact that $20 is recorded in the actual cost belt in the week of May 1 indicates that the item was started ahead of the planned date. At the date of the report this item was two days behind schedule, but showed a $50 saving.

Item B—The quantity of work originally estimated on was finished on time and with a $188 saving, as indicated by the figures under May 15, and by the ending of the solid lines. The dotted line indicates that the continued cost charges on this item cover extra quantities and that the over-run on the item is $598. The expenditures for extra quantity would be $598 + $188 = $786.

Item C—This item is three days ahead of schedule, but shows a loss of $390. No entry is shown in weeks in which no work is done. In actual practice, the same figure is carried forward in pencil to aid in summing, but is not inked so that it shows blank on the print.

Item D—The dot and dash line over the progress belt indicates that the item has either been sublet or canceled and that no revision of the budget line was made to compensate. The amount of credit taken for progress would be deducted from the gross saving or added to the gross over-run, when determining the final net performance on the operation.

Item E—This indicates an item which has not yet started though two weeks overdue. Such a condition would lead to a study of this item to determine whether it was essential to have it started at once, and the steps necessary to get under way.

Item F—This item is a week and a day behind schedule, but shows a saving of $54.

The summation of the whole hundred-odd items similarly recorded gives the weighted progress which quite accurately represents the actual conditions of the work.

For the master chart thin 10x10 to the inch cross-section paper 20 in. wide and long enough to take in the whole period was used, inking in every third horizontal line and every seventh vertical line. For the summary chart two standard 20x20 letter-size cross-section sheets were joined on the long edge. Profile paper would undoubtedly be better suited for this chart and give a neater looking print.

Street Car Subways Proposed for St. Louis Transit System

Rerouting of Street Car Lines and Putting Them in Subways in Business District to Be First Step in Transit Plan

IN SEPTEMBER of last year the Special Committee on Rapid Transit of the City of St. Louis submitted to the board of aldermen a report on transit conditions in the city with a number of recommendations looking toward prompt relief of at least part of the present congestion. The chief recommendations are that the existing street car lines be rerouted to minimize congestion on certain streets, and that subways be provided for the surface street car lines in the business districts as the first step towards developing a rapid transit system. Additional steps contemplate the extension of the subways and the substitution of rapid transit trains for street cars as soon as the length of the subways and the density of traffic warrant. An abstract of the report and the recommendations of the committee are given below.

Present Conditions—A check of the passenger traffic of the street car system of St. Louis indicates that there is no single route on which the traffic available would provide sufficient revenue for a rapid transit line over its entire length at the present time, this despite the fact that other large cities began the construction of rapid transit systems when the population was comparable to that of St. Louis at the present time, approximately 1,000,000 people. Moreover the committee is of the opinion that if funds were devoted to a single route the benefit would accrue to only a small portion of the riding public. In order that the money spent should be for the benefit of the whole riding public, the committee believes that the first expenditures of any considerable magnitude should be for placing the street car lines of the downtown districts in subways.

As an immediate relief, the committee recommends rerouting the street car lines through the primary business districts to get car lines off meandering routes on narrow streets where the movement is necessarily slow and onto streets where movement can be speeded up. This will release 4.3 miles of streets now used by street cars and make them available for more rapid movement of other forms of traffic. The estimated cost of the

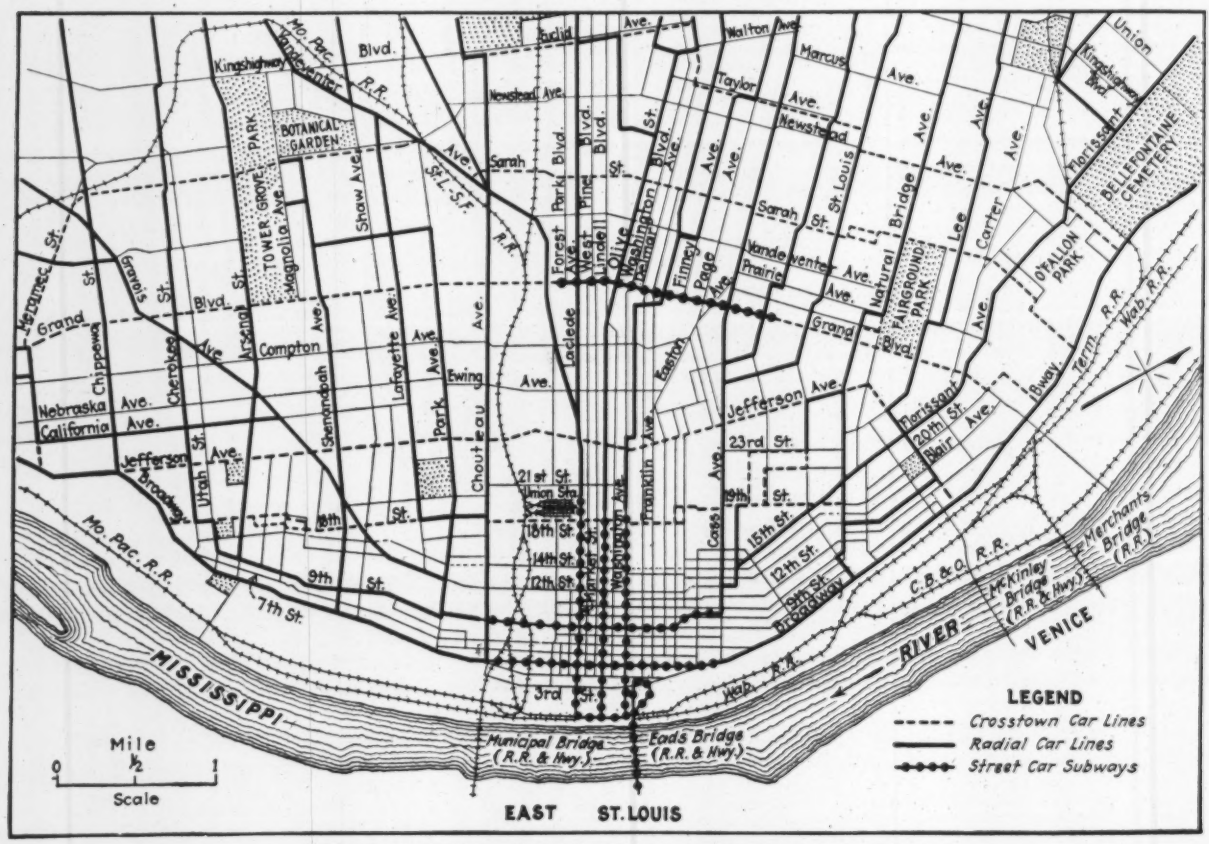


FIG. 1—FIRST STEP IN ST. LOUIS RAPID TRANSIT PLAN

change is placed at $150,000 and the annual saving in operating expenses is placed at the same amount. The construction of a new crosstown line past the Union Station in 18th Street from the McKinley bridge to Lemp Ave. and Broadway at an estimated cost of $300,000 is recommended.

Further improvements include the rerouting and extending of other crosstown and radial lines to include the rerouting of 22.3 miles of single-track and 95.5 miles of single-track extension; also, the removal of 69.8 miles. Further extensions either by bus or rail lines of 38.4 miles are proposed. Over a period of ten years this work is estimated to cost $275,000 per year.

Street Car Subways—The proposed street car subways to be built as the first step in the rapid transit system are shown in Fig. 1. The total amounts to 7.5

miles in the business district and an additional 8,000 ft. on Grand Avenue. The estimated cost of this work is placed at $46,000,000 and the committee estimates that fares would not be increased more than one-half cent per passenger.

After the completion of the first subways the construction of 15.5 miles of additional rapid transit lines, either subway or elevated, at an estimated cost of $30,000,000 is recommended. In this case it is estimated that most of the carrying charges will be offset by economies in operation. On the completion of this step rapid transit trains will be substituted for street cars in the Washington, Market and Ninth St. subways and operated as a separate but co-ordinated system. Street cars and buses would serve the outer terminals of this system. As a final step the committee recommends the extension of the rapid transit lines to the city limits, a total of 28.2 miles, at an estimated cost of $52,000,000.

The plan calls for the construction of a long plaza on the waterfront with storage tracks and transfer platforms on the lower decks and wide parking spaces on the upper deck. The sloping ground at the river front lends itself to this treatment.

Feeder Lines—In the second step six rapid transit lines will be extended about half way out to the city limits. As no one street car line carries enough passengers to support one of these transit lines, the street car lines approaching the terminal of each rapid transit line would be rerouted so as to bring their passengers to the subways. In the third step a similar rearrangement would be made. Subsequently, surface cars and buses would be used only as feeders to the main system from the territories lying between or beyond the rapid transit lines.

Routes and Character of Rapid Transit Lines—The committee has not determined upon the exact location of the rapid transit lines to be built as the second and third steps, nor does it make a specific recommendation as to whether the extensions of the rapid transit system be by elevated lines or subways. As the extensions of the rapid transit lines are made the routing of surface cars will be changed, some of the lines will be eliminated and others will be replaced by buses. The first step cannot be carried out without co-operation of the street railway company and the committee is of the opinion that even after the rapid transit lines are built the whole transportation system must be co-ordinated so that transfers can be made freely from any of the surface lines to the rapid transit system.

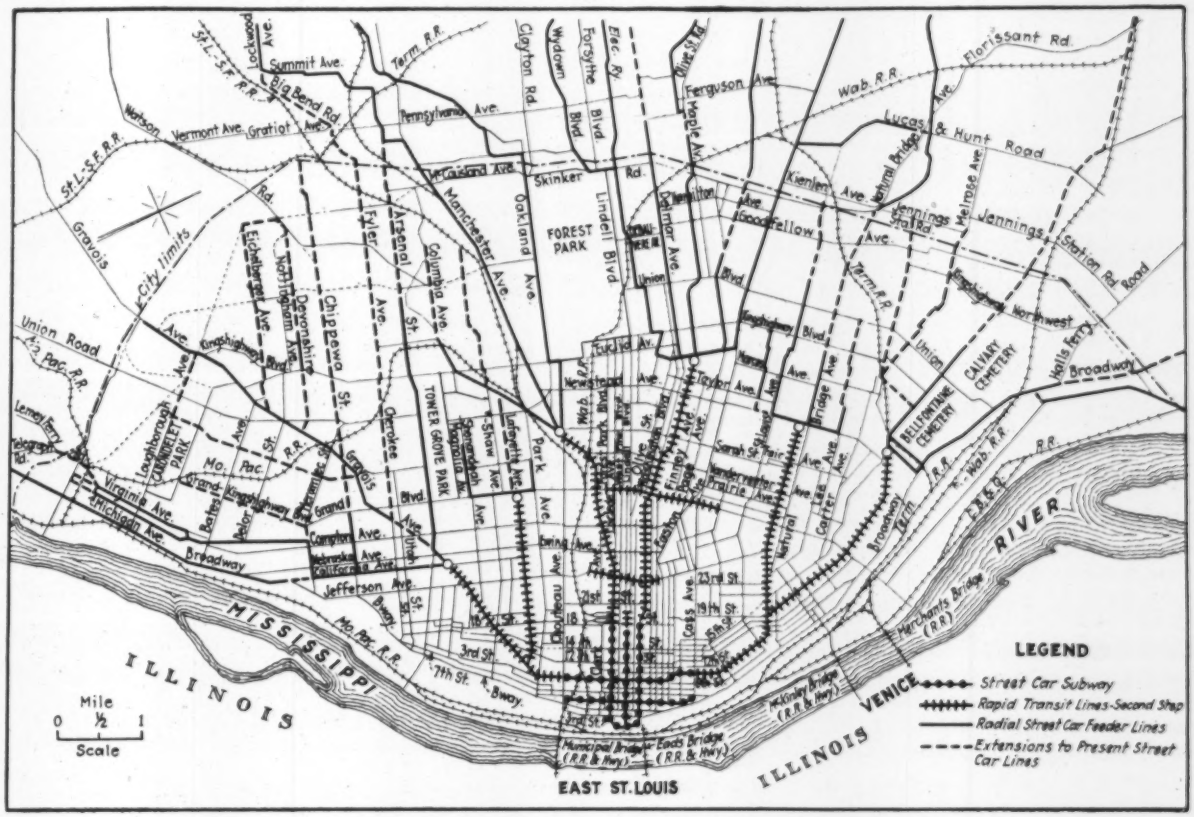


FIG. 2—SECOND STEP IN PLAN WITH SURFACE CAR LINES AS FEEDERS

Financing—The method of financing proposed is that three-quarters of the cost of the fixed improvements be charged as benefit assessments on property that will enjoy benefits and one-quarter be paid by public utility bonds of the city, the sinking fund and interest charges to be paid out of the general city funds, the tracks, cars, electrical and other equipment to be provided by the operating companies and added to its property value.

In order to insure future rerouting, extensions and construction of rapid transit lines the committee recommends that the city grant a franchise on a service-at-cost basis.

Personnel—The engineering work in connection with report was done by the firm of C. E. Smith & Co., Consulting Engineers, St. Louis.

Deep Water Caisson Sinking, Carquinez Strait Bridge

Framed Steel Piles Guide Timber Caissons Sunk in Water 90 Ft. Deep—Novel Anchorage Holds Caisson Against Swift Current—Novel Anti-Teredo Crib Construction

By George J. Calder

Formerly Resident Engineer, now Vice-President and General Manager, American Toll Bridge Co., San Francisco, Calif.

NATURAL conditions made very difficult work of the pier construction for the great bridge across Carquinez Strait of San Francisco Bay. In particular, the hazards imposed by foundations 135 ft. below the surface in water up to 90 ft. deep having swift and changing currents where the teredo destroys timber structures in ninety days, demanded unusual resource and inventiveness in developing methods and equipment for constructing piers 2 and 3 in the deepest channel. These, with pier 4 in shallower water, carry the two 1,100-ft. spans of the bridge. Their construction alone is described as it presents the prevailing foundation problems in their major proportions. The bridge itself with two cantilever spans of 1,100 ft. and the plan of construction as a whole were described by Charles Derleth, Jr., chief engineer, in *Engineering News-Record*, Sept. 24, 1925, p. 504. The substructure is twelve piers, or groups of pedestals, numbered 1 to 12 from the north side of the strait. Pier 2 consists of two pedestals and pier 3 of four pedestals, each 40 ft. square on top.

Water Depth, Sea Bottom and Currents—The water at piers 2 and 3 is 80 to 90 ft. deep; borings showed rock upon which the piers were to be founded at a depth of 135 ft. Mean high water is datum. At pier 3 there was 45 ft. of material overlying the rock—about 40 ft. of extremely fine black mud on a 5-ft. stratum of coarse sand and gravel. When in place the mud was very compact, stiff and hard, but when broken up and allowed to mix with water, due to the fineness of the particles, the resulting mixture resembled an emulsion. At pier 2 the material overlying bedrock was coarse sand.

The waters of Carquinez Strait have a maximum tidal variation of 8 ft. and a maximum current velocity of 7 ft. per second. Subaqueous current measurements indicated that at no time during the tidal range is the current velocity constant over the entire depth, and, particularly, current velocities following an ebb tide are extremely variable. It was found that for a considerable period of time following the ebb tide, the surface current was actually the reverse in direction to that of the subsurface current with a point of zero current varying from water surface to the bottom. Following flood tide the water mass all moved in one direction with varying velocities from surface to bottom. The effect of these water and sea bottom conditions is brought out in the account of the caisson sinking.

Teredo Occurrence and Hazard—Due to inoculation from San Francisco Bay, the water of Carquinez Strait at certain periods of the year is heavily infested with teredo spores. It has been observed that for water salinities below 0.5 per cent teredos will die; for salinities between 0.5 and 1.5 per cent teredos are dormant, and between 1.5 and 3 per cent they are extremely active. Carquinez Strait is the outlet for the Sacramento and San Joaquin rivers and during years of heavy runoff the waters of the Strait for a period of at least six months are diluted so that the salinity falls below 0.5 per cent. At other times the rate of timber destruction in these waters by teredos is extremely high, piles having been entirely destroyed in 2½ months (*Engineering News-Record*, Jan. 29, 1925, p. 189).

The years 1923 and 1924 were extremely dry years in California. Hence heavy teredo activity was expected during the summers of 1924 and 1925, and it became necessary to provide a thorough protection against

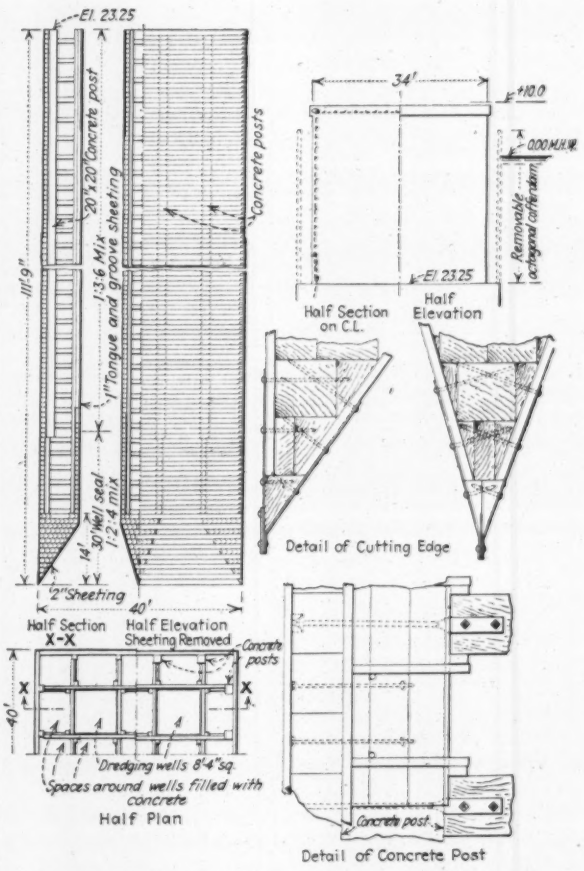


FIG. 1—CAISSON AND PEDESTAL FOR PIERS 3 AND 4

teredo attack for any wood used below water. Adoption of timber caissons (Fig. 1) then, for reasons indicated farther on, called for teredo protection of the structure.

To protect the timbers on the exterior of the cribs, and in the wells, from teredo attack, they were given a thorough coating, after calking, with a locally-made timber preservative paint. This preparation, an emulsified compound of asphalt and creosote, was put on with an air spray. During low temperatures the material was heated by steam. Timbers were next covered with a layer of impregnated tarred felt, tacked on. The felt was given a spray coat of preservative paint and the

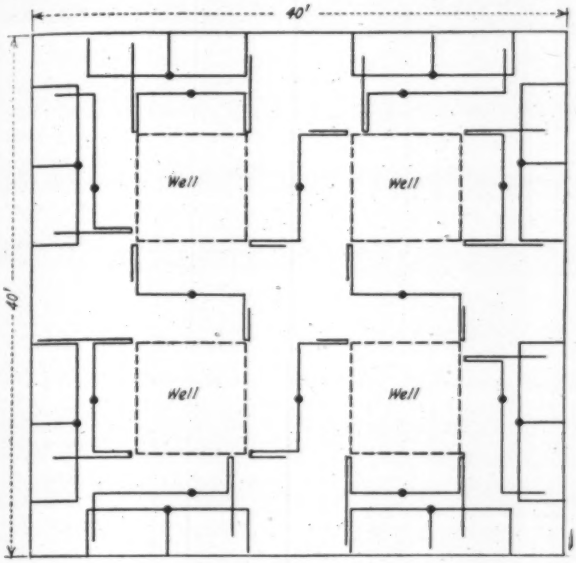


FIG. 2—CHART OF JET PIPE ARRANGEMENT

outer planking or sheathing was then spiked on. Finally, the sheathing was given a spray coat of the paint. This protection was sufficient to keep the timbers from attack for a period of at least one year, or until the crib was landed and concreted.

In order to protect the interior horizontal bracing timbers from teredo attack in case the exterior timbers had been entirely eaten away, the interior timbers were butt-framed against vertical concrete posts from a point about 30 ft. above the cutting edge to the top of the crib. These vertical concrete posts were formed and cast as the side timber walls of the crib were constructed. Since the bottom 30 ft. of the cribs will always be below mud line, timber was used for the vertical posts in that portion of the structure.

Caisson Design and Structure—Pneumatic sinking was not feasible because of the depth, 135-ft., of the foundations. From the beginning, therefore, some adaptation of the crib or open caisson method was planned. Three schemes were studied: (1) cylindrical steel shells with central dredging wells; (2) cylindrical concrete shells with central dredging wells; and (3) concrete-filled timber cribs with four dredging wells.

The steel shell type was abandoned on account of excessive cost. With concrete cylinders the condition of flotation and rather high or indeterminate cost were the great disadvantages. It was found that the practical limit of height for casting the concrete cylinder before launching was about 35 ft. and in order to maintain flotation the central dredging well would need to be bulkheaded thus raising the center of gravity of the cylinder above the center of buoyancy. This relatively unstable condition would exist throughout the entire construction of the pedestal until the cutting edge reached the floor of the strait. The necessity for anchoring the pedestal in deep and swift water during construction demanded a method requiring the minimum time between launching and embedding the cutting edge in the strait bottom. After extensive comparative studies, the chief engineer selected the concrete-filled timber crib method as the cheapest, quickest and safest.

With water depths of about 80 ft., the anticipated scour when the cutting edge approached the bottom was assumed as 20 ft. The assumed water depth, including scour was therefore 100 ft., actual scour depth during sinking being from 18 to 23 ft. Flotation studies indicated that 1 ft. of concrete in the crib chambers would sink the crib approximately 1.6 ft. and that 1 ft. of crib construction would cause a further sinking of 0.3 ft. Crib and dredging well walls and crib bracing were designed to resist a maximum unbalanced water head of 45 ft.

All cribs were designed with a solid timber cutting edge thirteen courses high shod with a steel plate and angle shoe. The cutting edge on the first two cribs was blunt, about 10 in. wide; on the other four cribs it was made sharp. Sinking operations indicated that the sharp cutting edge gave a little greater sinking speed but that stability during sinking and the landing and the plumbing of the crib after landing were considerably aided by the blunt edge. The cribs were from 110 to 112 ft. high, and a square section was adopted because the framing is simpler, the arrangement of the dredging wells is more satisfactory, and the anchorage system could be more easily and cheaply constructed than for an octagonal crib. The four dredging wells, 8 ft. square, placed symmetrically, gave good control in sinking.

Jet System to Aid Sinking—An exceptional development of water jets to aid caisson sinking was worked out as shown by Figs. 2 and 3. The system consisted of (1) outside or friction relief jets and (2) inside or cutting jets.

The outside jets were built into the exterior timbers of the cutting edge, and were placed on all four sides of

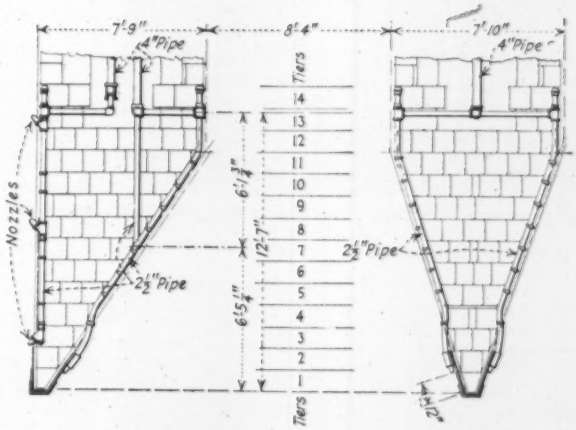


FIG. 3—DETAIL OF JET PIPES AT CAISSON CUTTING EDGES

the crib at approximately 6-ft. centers horizontally. At each 6-ft. interval three nozzles or jets were set vertically, the first nozzle being about 2 ft. above the bottom of the steel cutting shoe and pointing downward at an angle of 45 deg. It was assumed that this bottom jet would act both as cutting jet and a friction relief jet. Above the bottom nozzle were two additional nozzles spaced 4 ft. 7½ in. vertically, and pointing upward at an angle of 45 deg. The nozzles were ¾-in. and were fed by a 2½-in. supply pipe connected to 4-in. riser pipes in groups of three, so that one 4-in. riser supplied nine nozzles. The riser pipes were carried up through the crib chambers to the top of the removable cofferdam. The tops of the risers were then connected by flexible hose to a horizontal 8-in. header pipe attached

to the cofferdam framing. Finally, the header pipes were connected to a battery of pressure pumps on barges anchored adjacent to the crib.

Both inside and outside cutting jets were spaced 10 ft. apart and each had a nozzle diameter of 1 in. Each nozzle was supplied by a 2½-in. pipe, and the supply pipes were connected in groups of two to 4-in. risers in the manner just described for the outside jets. The cutting jet system was designed on the assumption that for each 10 lin.ft. of cutting edge sufficient cutting capacity would be furnished by a 1-in. diameter smooth nozzle discharging 200 g.p.m. of water. Using Merriman's nozzle pressure formula:

$$P = \left[\frac{Q}{29.83\,D^2}\right]^2 \left[\left(\frac{1}{C}\right)^2 - \frac{(D)^4}{d}\right]$$

gave 46.4 lb. per sq.in. as the required nozzle pressure. Allowance for friction losses gave 76.7 lb. per sq.in. as the required pressure at the top of the riser.

Friction relief jets were designed assuming a ¾-in. nozzle discharging at one-half the velocity of the cutting jets. The contractor adopted the engineer's design for the jet system and furnished as pumping equipment to operate it:

Unit A—One 6-in., 2-stage turbine pump with an 8-in. suction and a 6-in. flexible discharge connection to the header pipe system. This pump was direct-connected to a 150-hp. motor.

Unit B—Two 6-in., single-stage, single-suction pumps, with 8-in. suctions and 6-in. discharges. Each pump was direct-connected to a 110-hp. motor. These pumps were connected in series and the unit thus obtained delivered 1,900 g.p.m. at 140 lb. per sq.in.

It was not necessary to operate more than eight cutting jets at one time. The friction relief jets were seldom used. Experience with the system in the material encountered indicated that a smaller number of relief jets would have sufficed, but that the horizontal spacing was about right. The cutting jets were used continuously during the sinking of the cribs. It would have been an advantage to have had the cutting jets spaced 5 ft. instead of 10 ft. apart.

Anchors and Caisson Guides—To control each caisson in sinking, an anchorage system, Fig. 4, suggested by D. H. Duncanson was designed in the resident engineer's office under the direction of the chief engineer. The system consisted of a set of six structural steel spuds, or guide columns, 120 ft. long, weighing approximately 30 tons, and driven vertically in the waters and mud of the strait. Two columns were driven on the west or downstream side of the crib, two on the east or upstream side, and one each on the north and south sides, one of the latter being driven after the crib had been floated into the frame. The tops of the columns were framed together by steel girders and tie rods, and by horizontal and vertical timber trusses.

The top of each east and west column was fitted with a steel yoke to which was bolted the sheave connection of the 7-part 1-in. steel cable take-up tackle. This tackle connected to the free end of a 1⅞-in. studded-link chain. Each chain and tackle connection was carried on a small anchorage barge, four of which were used with each frame, located 60 to 80 ft. up- or downstream from the crib. The outer end of each 1⅞-in. chain was attached to a 16,000-lb. ship anchor laid in the floor of the strait approximately 800 ft. up- or downstream from the center line of the crib. The north and south columns were not anchored as the directions of the currents are at all times approximately east and west. In order to anchor the frame against possible north and south cross-currents, and wind, the east and west

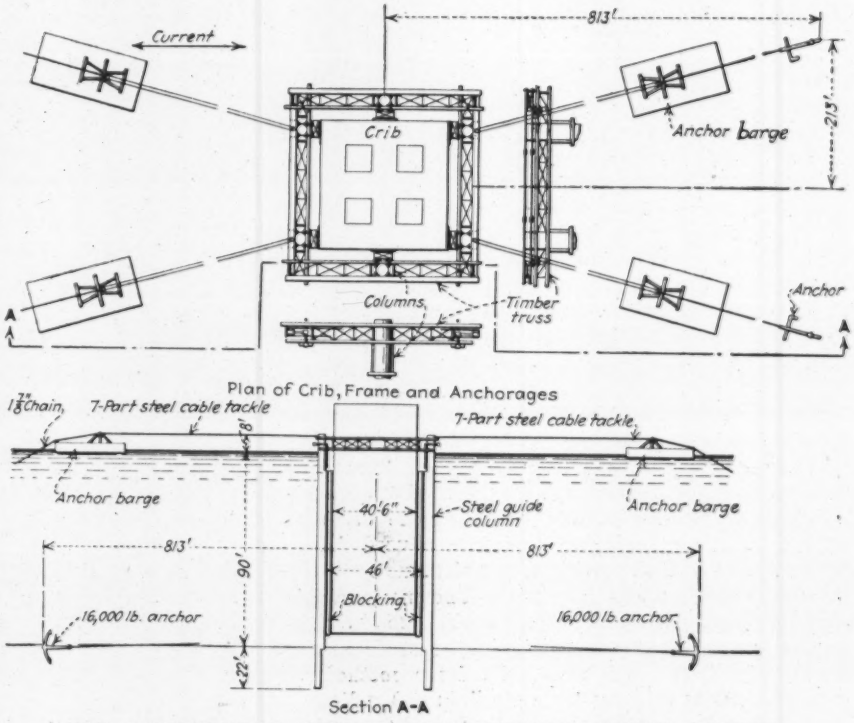


FIG. 4—DIAGRAM OF ANCHORS AND GUIDES FOR SINKING CAISSONS

anchorage system was flared as shown in the drawing.

In assembling the anchorage frame a barge was anchored temporarily in the position to be later occupied by the crib. Anchors were laid and the chains were brought up to the small anchor barges. The north, east and west columns were then spotted by triangulation and driven by a steam hammer, assisted when necessary by two 3-in. jets, one worked down alongside the column, and a second passed down the center. It was necessary to spot the columns in slack water, after which they were driven 20 to 22 ft. into the bottom. The driving time varied according to material; some columns were put down in one or two hours, while others required 8 to 20 hours.

After the north, east and west columns were driven, the steel collar beams were placed, the timber-stiffening trusses erected, and the anchoring tackle attached. Three sides of the anchorage frame were thus completed before the crib was brought into place, Fig. 5. The cribs were constructed to tier 19, launched, towed

to position, and moored in the frame. With the crib in position, the sixth or south column was driven, and the collar framing was completed. The anchorage frames were constructed large enough to allow a 3-ft. clearance on all sides of the crib, and the top was planked over all around the crib for a working platform.

In designing the anchorage system, two current velocities were considered; an extreme velocity of 7 ft. and an average velocity of 5 ft. per second. These velocities gave lateral pressures of 96 lb. per sq.ft., and 49 lb. per sq.ft., respectively. Allowing a factor of 80 per cent for the square face of the crib gave lateral pressures of approximately 80 lb. per sq.ft. for the extreme velocity and 45 lb. per sq.ft. for the average. Since the velocity over the entire depth was variable and since it was not probable that the extreme case would be encountered during construction, a pressure of 65 lb. per sq.ft. was assumed and the usual safe working stresses for timber and steel were applied.

The east and west columns were designed for a lateral pressure resulting from the caisson acting on the column at its midpoint, plus the pressure on the exposed face of the column, plus an additional top pull of a 40-ft. barge. The vertical load was assumed as the weight of the column plus the vertical component of the cable pull, plus a load of 200 lb. per sq.ft. on the working platform. The north and south columns were made similar to the east and west columns in order that the entire system would be interchangeable. The vertical trusses were designed to carry a 200-lb. per sq.ft. floor load on the working platform. The anchorage pull per anchor was

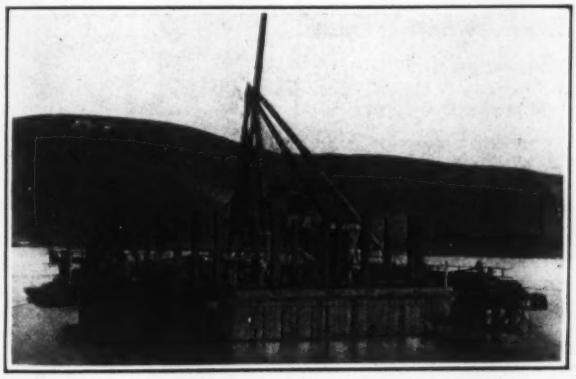


FIG. 5—CRIB IN PLACE WITHIN STEEL GUIDE FRAME
The sixth steel column is yet to be placed on the side of the crib in the foreground. Tops of the steel columns show at corners of the frame.

assumed at 100,000 lb. This allowed for a designed column pull of 80,000 lb. plus 20,000 lb. for anchored barges and floating equipment. No data were available for the holding power of anchors. The use of a 16,000 lb. anchor was dictated solely by judgment.

Two complete guide frame systems were used, being moved to new locations as the work progressed. For the first frame the columns were 120 ft. long. In the second they were made 128 ft. long as it was felt that scour might be sufficient to require this additional length. The longer columns were found necessary at only one crib.

Sinking Procedure and Progress—The cribs were framed on a construction dock at shore up to the time of launching. For cribs in their frames, material was transported from the dock barges, and delivered to the crib by two floating derricks. Crib framing was carried up 12 to 15 courses at a time, after which concrete was poured and the crib was sunk until the freeboard was reduced to about 8 ft. The concrete mixed in a floating plant was chuted from a tower on the mixing barge to the top of the crib, and then conveyed to the crib chambers by articulated pipes. The usual pour was about 200 cu.yd.

Just before the cutting edge reached the bottom, the top center of each guide column was accurately located by triangulation and the inclination of the column from the vertical was determined. The location of the column at mud line was then calculated and weighted blocks dimensioned to suit this calculation were let down on cables alongside the columns, thus blocking the crib in its final position for landing. A clearance of about 3 in. was allowed between the crib and the blocks. After the blocks were in position, the crib was settled into the bottom by pouring concrete in the crib chambers at the end of an ebb or a flood tide. Cribs were located by this method with a lateral variation of not more than 0.5 ft. from true calculated position.

Sinking was carried on by dredging in the wells and by operating the jets. The average rate was 0.5 ft. per shift of 8 hours, and the maximum rate was 1.3 ft. The crib was sunk until the cutting edge reached the high point of the rock surface. The final 2 or 3 ft. of penetration was accomplished by careful dredging and jet operation, assisted by a discharge of two to three sticks of 40-per cent dynamite in each well.

After the crib was landed, the material at the bottoms of the wells was cleaned out by dredging, jetting, and by water ejectors. The well was sealed with 30 ft. of 1:2:4 concrete deposited by a 2-yd. marine bucket. The wells were pumped down after seven days, the concrete surface of the seal was cleaned off, and the remainder of the well shaft was filled with 1:3:6 concrete. The circular portion of the pier was then formed and constructed, the octagonal cofferdam removed, and the pier completed.

The only trouble in sinking was with the first crib, when the cutting edge reached approximately El. —122. On Sept. 21, 1925, concrete was poured in the crib chambers. Previous to this, soundings indicated that the dredging was being carried about 7 ft. below the cutting edge. Immediately after the Sept. 21 concreting, sounding indicated a dredged depth of only 4 ft. below the cutting edge, and since the crib had not moved during concreting, the inference was that material had sloughed into the dredging well bottoms.

Dredging was resumed on the morning of Sept. 22, and during the early afternoon several cutting jets were operated. Immediately preceding the jetting, soundings showed the dredged bottom to be again 7 ft. below the cutting edge. Almost immediately after the jets were started, the crib lurched southward until it was 13 ft. out of plumb in a height of 110 ft., and the south cutting edge moved from El. —122 to El. —127.5, the north cutting edge remaining practically stationary. The lurching was almost instantaneous, and as the crib leaned it carried with it the entire anchorage frame and columns.

A cable sling was placed around the top of the crib and connected through tackle to a system of anchors and chains placed approximately 700 ft. north. During the entire righting operations a strain was kept on this tackle. Jetting was prosecuted on the outside of the crib on the high side and dredging and jetting were carried on through the north dredging wells. On Sept.

25 the crib started to move back and by Oct. 4 it was again plumb. During the lurch and righting operations, the crib moved downward to El. —127.5 and drifted northward 0.6 ft. Dredging for the remaining cribs was not carried more than 4 ft. below cutting edge.

Cost and Personnel—The total cost of constructing the six pedestals, including labor, material, equipment, anchorage frames, construction dock, and all overhead and superintendence, but not including engineering, was $1,623,452.76. As the total volume occupied by the six pedestals was 45,290 cu.yd., the cost per cubic yard was $35.85.

The officials of the American Toll Bridge Co. are President, Oscar H. Klatt, succeeding Aven J. Hanford; vice-president and general manager, George J. Calder; and secretary, John T. Whitmire. The company's engineering staff consists of C. Derleth, Jr., chief engineer; William H. Burr, consulting engineer; D. B. Steinman, designing engineer; and, until recently, George J. Calder, resident engineer. The timber cribs and anchorage systems were designed and detailed at the resident engineer's office by George C. Haun. H. F. Topping designed the jet pipe system.

The foundation work was begun on a flat-fee basis by the Duncanson-Harrelson Co., of San Francisco, D. H. Duncanson, president and general superintendent, with the chief engineer of the American Toll Bridge Co. acting as the contractor's engineer. This firm started the construction of two of the cribs and constructed one anchorage frame. Subsequent bonding arrangements for the final financing of the project demanded a lump sum contract for the completion of the foundation work.

Bids were then called for, and a contract for the completion of the substructure was awarded to the Missouri Valley Bridge & Iron Co., of Leavenworth, Kan., E. H. Connor, chief engineer, C. F. Greever, general superintendent, F. E. Washburn, engineer in charge, and J. E. Taber, superintendent. This firm was given the privilege of proposing changes in the design if it so desired. It constructed the four remaining cribs substantially in accordance with the original design, but with modified timber sizes and somewhat revised details.

The steel superstructure is now being erected by the U. S. Steel Products Co., and the bridge will be completed and opened to traffic on or about May 1, 1927.

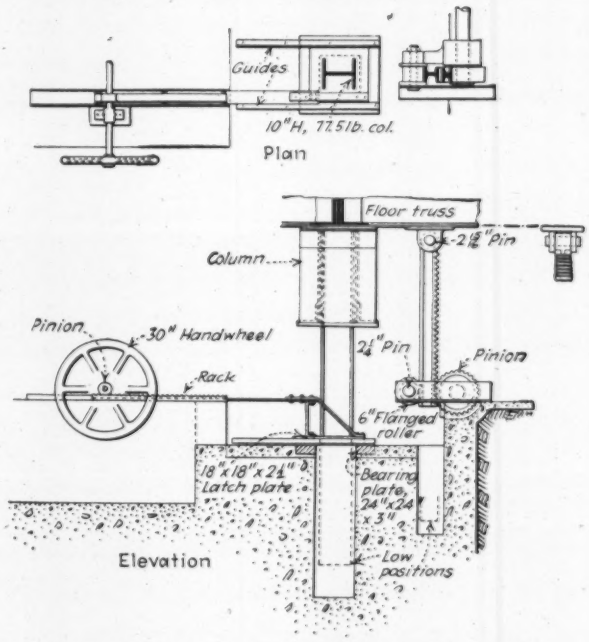
New Lines for Argentine State Railways

It has been announced that 20,000,000 pesos ($8,300,000) per year has been apportioned by an Argentine presidential decree for the completion of several unfinished lines on the Argentine State Railways, according to a report to the United States Department of Commerce. The unfinished lines that will probably receive attention according to reports in Argentina are: Salta to Chile, via the Andes; Embarcación to Yacuiba (Bolivia); Metan to Barranqueras; Antilla to Rosario de la Frontera; La Banda to Santiago del Estero; San Juan to Jachal; Milagro to Quines; Federal to Curuzu-Guatia; San Nicolas to Arroyo Dulce; San Antonio to Patagones; Kil. 448 to Lake Nahuel Huapi; Federal to Concordia; Kil. 448 to Arroyo Pescado; La Paz-Filiciano-San Jaime; Cordoba to La Puerta; Algarrobal to Mendoza; Esquina to Sauce; Cauruzu-Guatia to Paso de los Libres; Nare to Helvecia; Formosa to Embarcación.

Auditorium Floor Is Level or Inclined as Desired

Steel Trusses Supporting 78 x 115-Ft. Floor Arranged So One End Can Be Lowered to Convert Ball Room Into Theater

THE recently completed Memorial Auditorium at Sacramento, Calif., has in its main hall the novel feature of convertibility from a level floor to an inclined floor. In addition to this adaptability to different uses the scheme gives an increased area with the floor in the level position because the use of sectional flooring over the orchestra pit increases the floor space by that amount plus the stage area. Special seats that would

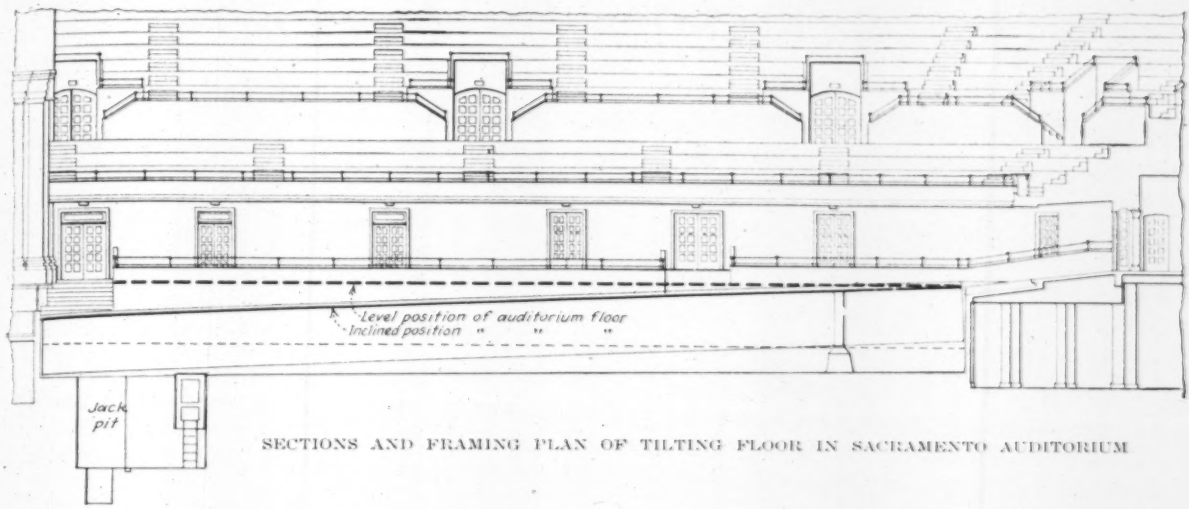


PLAN AND ELEVATION OF LATCH PLATE, COLUMN AND EQUALIZER

be comfortable when placed on the incline were made for use when the hall is serving as a theater. The entire additional cost incidental to this special feature of the building, including design of the floor supports and apparatus for operating it, is estimated at between $12,000 and $14,000.

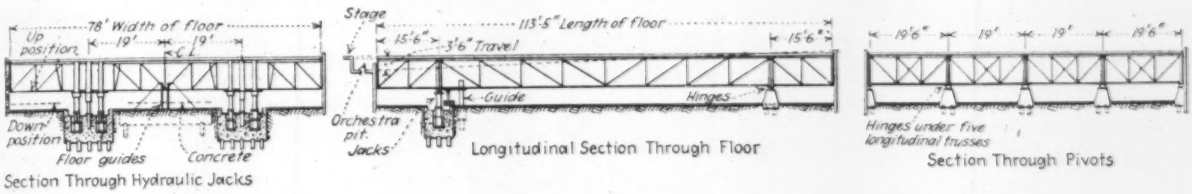
The floor is supported mainly on five longitudinal steel trusses spaced about 19 ft. apart which rest on hinges at one end and with the other end arranged to be raised or lowered by hydraulic jacks. There are two main transverse trusses, one at the hinges and one over the jacks. These trusses with suitable bracing constitute the framework of the tilting platform, to which wood plates were bolted as nailing strips for the laminated floor.

The load is carried by the jacks only during the time they are being raised or lowered. When in either the up or the down position the weight is transferred from the jacks to two 10-in. steel columns. These columns have shoulders which rest on bearing plates when lowered; when raised an 18x18x2½-in. latch plate is slid beneath each one by the mechanism shown in the drawing.

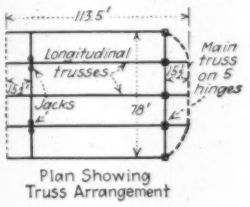


SECTIONS AND FRAMING PLAN OF TILTING FLOOR IN SACRAMENTO AUDITORIUM

These columns are directly beneath two of the longitudinal trusses. The latch-plate operating mechanism is interlocked so that both plates operate simultaneously. The time required for raising the jacks is 6 min. and for lowering, 5 min.

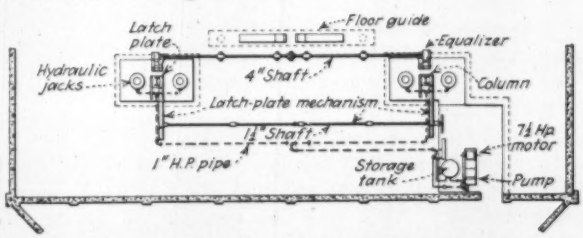


SKETCH SHOWING FLOOR TRUSS FRAMING PLAN



Four hydraulic jacks are used, as shown in the drawing. They are served by a 7½-hp. motor geared to a pump that delivers to a 180-gal. tank. The maximum pressure is 400 lb. per sq.in., the jacks being served through 1-in. hydraulic high-pressure pipe.

To avoid the danger that might arise if one pair of jacks worked faster than the other, a vertical rack is pinned beneath two of the longitudinal trusses near the permanent column support. These racks engage two pinions interconnected by 4-in. shafting so that if there are minor inequalities in the thrust of the two pairs of jacks this interlocking device partly transfers and helps to equalize the thrust. The travel of the plungers of the jacks is 3 ft. but the total travel of the extreme ends of the tilting floor is more, of course, the total difference in level amounting to 4 ft.



PLAN OF HYDRAULIC JACK LIFTING MECHANISM

Patents have been applied for on the scheme for raising and lowering the floor by James S. Dean of Dean & Dean, architects, Sacramento, who devised the plan. The structural engineer on the building was M. W. Sahlberg, and Chris H. Snyder was the consulting structural engineer.

Panama Canal Locks Overhauled

Overhaul of the Panama Canal locks at Gatun, commenced in January, will be completed in about three months. In addition to the routine overhaul of gates, valves and underwater parts, 40 cylindrical valves will be installed to replace those which have been in use since the completion of the Canal. These new valves are of improved design, with bronze wearing surfaces that can be renewed. Half of the valves were manufactured by the mechanical division of the canal and the others were procured from the United States. It is stated in the Panama Canal *Bulletin* that during the overhaul period, first one side of the duplicate locks will be out of commission and then the other. The side in use will be in service 24 hours per day. This schedule, combined with the anchorage in Gatun Lake, south of the locks, is expected to take care of the traffic, which is usually heavy at this time of the year and will include the U. S. battle fleet. Two 8-hr. shifts per day will be worked, with three similar shifts on those items which determine the date of completion. There will be no work on Sundays and holidays. The program is 41 working days for the side first unwatered, 4 to 6 days to shift over, and 35 to complete the other side, or approximately three months in all. The next overhaul planned is for the Pedro Miguel and Miraflores locks, in 1929.

Measuring Maintenance Efficiency by Unit Costs

Upkeep Costs Compared by Administration Units from Divisions to Single Patrols on Pennsylvania Roads

By W. H. Connell
Engineering Executive, Pennsylvania Highway Department, Harrisburg, Pa.

HIGHWAY MAINTENANCE is big business. It involves the budgeting of finances, the selection and purchasing of materials and equipment, the upkeep of plant buildings, machines and tools, the formulation and improvement of production methods, the organization, education and inspiration of workmen to degrees equivalent to similar operations of the largest public service corporations. This article presents one phase of modern road maintenance business as developed in a state which has advanced far in the business conduct of its highway work. Its educational and inspirational value is high. —Editor.

EVERY business should have some means of measuring the service rendered by the individuals who turn out the work. The kind of work, of course, varies with the character of the business, but in these days, in order to be successful in business, a measure of the service rendered by the respective employees is essential. It is a basis on which the output is determined. In the steel business the service of the individual is measured on a piecework basis. This method is very generally applied in the manufacturing business. In the coal business the service of the individual is measured on a quantity production basis. In stenographic and clerical work the comparative measure of service is based upon the amount of work turned out by the individual. Even bricklayers have been working for years on a production basis.

In the highway business comparative unit costs measure not only the quantity but also the cost of like work performed by individuals or groups of individuals.

Application of Cost System—The application of comparative unit costs to this business in Pennsylvania can be readily visualized if we bear in mind that the state has an area of about 45,000 sq. miles, and the highway system, under the jurisdiction of the Department of Highways, comprises about 12,000 miles. The plan by which the maintenance work is controlled consists of dividing the state into four geographical divisions each under the supervision of a division engineer. The state is further divided into districts of which there are fifteen, each under the supervision of a district engineer. These district engineers report to their respective division engineers. The districts are further divided into sections, of which there are fifty-two in the state, each under the supervision of a maintenance superintendent who reports to his respective district engineer. These sections are further divided into sub-sections, each under the supervision of a foreman or caretaker reporting to his respective superintendent.

The comparative unit costs apply to all classes of maintenance work. The first analysis of these costs compares the costs of the work under the jurisdiction of each division engineer and as he in turn holds the district engineers responsible in their respective districts, the costs are subdivided to compare the work under the jurisdiction of each district engineer. Since the district engineers in turn hold the superintendents responsible for the work in their respective sections, the costs are further subdivided to show the comparative costs of the work under the jurisdiction of each superintendent. Finally, as the superintendents hold the foremen or caretakers in charge of the sub-sections responsible, it is necessary to sub-divide further the costs, so that a comparison can be made of the costs of the work under the jurisdiction of each foreman.

The whole plan simply means that the administrative officers hold the division engineers responsible and compare their costs. The division engineers in turn must do likewise with the district engineers who, in turn, for self protection, must do likewise with the superintendents, and the superintendents in turn, for self-protection, must do likewise with the foremen and caretakers. There is no mystery in connection with this plan. The only wonder is that it is not used in all engineering businesses of this character. It would be if the states, like business corporations, were in competition with each other. No business can be successful unless it is conducted on sound business principles. This system of comparative costs is simply an illustration of one of the means used by highway engineers to conduct their work on a sound business basis.

Value of Cost Comparison—It will readily be seen that these costs will bring about a spirit of competition and friendly rivalry which immediately results in raising the standard of the morale of the organization as well as in increasing the production at a decreased cost. It makes each foreman or caretaker a more important factor in the organization than he formerly was and schools him in business. It teaches him economics as it makes him appreciate the value of a dollar as applied to his work. The result of such a system in this work invariably has been that it has made the men more appreciative of the importance of their job. It gives them an added interest and sets them thinking in a bigger way about the problems involved. In the first place, the spirit of competition gets into their blood and if they are any good at all, for the sake of this alone they will be very jealous of the quality of their work and will try to reduce their costs as much as possible in order to beat each other.

As a result of discussions at general meetings where the costs are compared, the foreman and caretakers have an opportunity to benefit by the methods employed by the men who are doing the best quality of work at the lowest cost. They are impressed with the fact that they must not sacrifice quality for quantity production; that the work they are doing is for the purpose of giving the public the very best transportation service; and that the department is a public service department, which, like public service corporations, must make every effort to give service to the public at the least cost commensurate with good service.

There is no question but that this system of comparative costs increases the production and decreases the costs. This has been demonstrated in every instance where it has been applied.

Instruction by Inspection Trips—Another plan to stimulate the spirit of friendly rivalry among the maintenance employees was put into effect early in the administration. This was the practice of having the maintenance men inspect each other's work, at least once a year, and determine among themselves who is

doing the best work. The date for the inspection trip is designated by the engineering executive; a one- or two-day trip is made through the district, the length of time depending upon the size of the district. The district engineer, the superintendent, and all the foremen and caretakers in that district, make the trip. As the party rides over each section of highway, each man rates the quality of the various phases of maintenance on that section and at the conclusion of the trip votes, on the basis of the ratings he has made, for the foreman and caretaker who he thinks has the best maintained section of each type of road in the district. Prizes are given to the foremen and caretakers making the best showing. In the evening, a meeting is held at which the methods and results observed are discussed.

Before this plan was put into effect, foreman Jones and foreman Smith might have worked in the same county for ten years without knowing each other, except by hearsay, unless they were on adjoining sections. Whenever foreman Jones was told that his work was not up to the standard of foreman Smith's, he took the criticism with a grain of salt. Now, however, foreman Jones has an opportunity to see for himself where foreman Smith's work is superior. Each foreman and caretaker knows that all the other foremen and caretakers in the district are going to scrutinize his work.

At the end of the working season each division engineer takes his district engineers and superintendents on a three-day trip, which includes visits to every superintendent's district in the division and to all the major maintenance projects under way or completed during the previous season. Meetings are held in the evenings to discuss the condition observed during the day when the trip has been completed. The superintendent having the best-maintained district is selected by ballot and is given recognition by the award of a suitable trophy.

Wolverhampton Sewage Sludge Piped to Private Farms

FOR some years past the sludge from the sedimentation tanks of the sewage-works of Wolverhampton England, has been forced by means of compressed air through a pipe line and distributed through gutters or like furrows formed by a plow onto privately owned farm lands. This method has superseded sludge pressing. According to William Clifford, manager and chemist of the Wolverhampton sewage-works, in a paper presented at a conference of engineers and surveyors held in connection with the Royal Sanitary Institute Congress (London *Surveyor*, July 16), the farmers are much better pleased with this sludge and take it more readily than they did pressed sludge. No charge is made either for the sludge or for its delivery to the farmers. The paper does not make clear whether any of the labor of distributing the sludge over the land is done by the farmer, but there appears to be no charge for the sludge at least up to the point where it reaches their land.

The sludge has a water content of 85 to 95 per cent and averages 90 per cent. In volume it is about 0.5 per cent that of the sewage. The sludge is forced to the land by the air compressors and rams formerly used to deliver it to the sludge presses. The force main in the immediate vicinity of the sewage-works is a 6-in. pipe laid underground. From this pipe connections are made with 4-in. distributing pipes having "a sort of semi ball-and-socket joint with loose flanges" that "allows the pipe line to follow the contour of the ground and the direction of the hedges." The distributing pipe is in 12- to 16-ft. lengths, easily handled by two men. Mr. Clifford states that "latterly spigot and socket pipe, just sleeved together, without any packing, has been used."

The sludge distributing pipe is brought to the highest point on the land to be served and discharges into a header ditch from which "gutters made with a ridge plow to the best fall of the land" extend at intervals of 8 to 10 ft. Arable land is plowed before the sludge is applied. In the case of using the sludge on grass land, furrows are turned with an ordinary plow and the sod replaced after the sludge has been distributed. The distributing gutter being used is dammed with a spadeful of soil so as to distribute the sludge over a few square yards at a time. On grass land the sludge is brushed over the surface by means of bass brooms. With the aid of two men 6,000 U. S. gal. per hr. can be distributed on arable land, but on grass land three men are required to handle this amount.

An acre of land will take about 60,000 U. S. gal. of 90 per cent water-content sludge per acre "for a good dressing." About one acre of land is required for every 12 U. S. m.g. of sewage, but as the land does not receive sludge every year at least one acre is required per 3 U. S. m.g. of sewage per year. Land used for market gardens, however, will take sludge every year. Taking into account that not all land in a given area is available, the "pipe line may have to be extended to cover ten times" the area actually receiving sewage. Mr. Clifford states that "200 acres are ample for the sedimented sludge from a population of 200,000; or one acre of available land for every 1,000 population." [It should be remembered that British sewage is strong.—Editor.]

Some 23 to 24 long tons of solid matter are applied per acre, or "about seven times the amount that the farmer applied when he carted the pressed sludge" to his land.

From May to August the sludge is not used on dairy and stock farms, but "a farmer who grows vegetables for the market will take sludge nearly all summer." When the sludge is not taken by the farmer use is made of "air-drying on special plots." Mr. Clifford adds that "the area so required is little more than that needed for the tip [dump] when the sludge was pressed."

The working cost per annum for the disposal of 27,000 long tons of sewage sludge (90 per cent average water content) is given in the paper as £670. As far back as 1910 the cost of pressing the sludge from the Wolverhampton works and either taking it to a tip or sending it away by boats was £1,291. Assuming an increase in price of labor and materials of an even 100 per cent, which Mr. Clifford intimates is too small, the cost of sludge disposal by pressing and tipping would be £2,582 for the volume treated in 1910 [not given in the paper].

The length and rise of the Wolverhampton force main is not given (both apparently small), but the author states that the average "power demand is approximately 1.0 unit of electricity per [long] ton of sludge sent away.

High-Early-Strength Concrete Speeds Stadium Building

Form Removal Possible in Half the Usual Time by Adding a Bag of Cement per Batch and Highly Mechanized Concrete Control a Contributory Element of Speed

CO-ORDINATING dealer delivery of material as used, the precise mechanization of concrete mixing and handling, and a high early-strength concrete, exceptional speed has been secured in building the new stadium for Northwestern University at Evanston, Ill. The use of high early-strength concrete, which made it safe to remove forms and shoring in half the ordinary time, is of particular interest to constructors. Briefly, concrete structure, columns, beams and slabs could be completely stripped in a week whereas with ordinary proportioning and mixing it stayed in the forms eight days and then was reshored for twenty days. Further, while the special mix stands out as a factor in a fast work schedule there were other helps of plant and materials service which are worth observing.

Actual construction of the stadium began May 7, 1926, and the first football game was scheduled for Oct. 2, less than five months ahead. The contract required that 25,000 seats be available for the initial game and that all of the 36,000 of the first sections be ready two weeks later, on Oct. 16. In short, a structure costing over a million dollars, divided into two massive units, one on either side of the field, and necessitating two complete sets of equipment and two different organizations of labor, had to be entirely finished in a little over five months. To add speed incentive to the undertaking, a clause in the contract called for a penalty of 50c. for each seat that the contractor did not have ready at the prescribed time. Another condition of the contract was that the center playing field should first be graded, seeded and fenced and during all the work kept free of plant and indeed free of trespass of any kind. This was primarily the reason for separate outfits and working crews for the two halves of the structure as shown on the diagram plan.

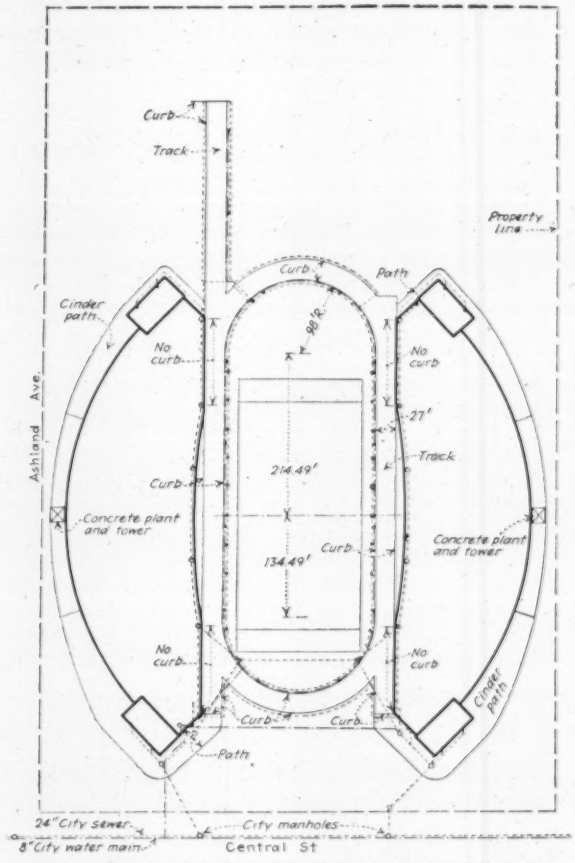


FIG. 1—LAYOUT OF STANDS AND GROUND STRUCTURES, NORTHWESTERN UNIVERSITY STADIUM

Dealer Materials Delivery—As also indicated by the plan, with the playing field eliminated, there was not too much space for materials handling and storage. On the west and south, however, there were main streets and on the east side there was room for a

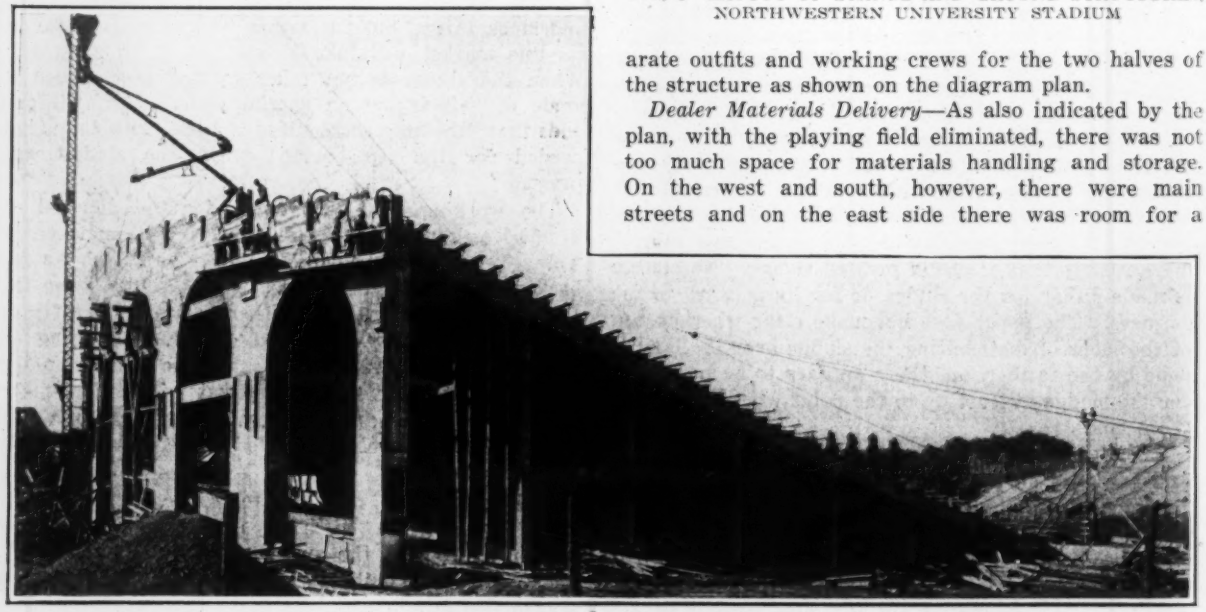


FIG. 2—CONCRETE STRUCTURE FOR FIRST DECK, NORTH WESTERN STADIUM

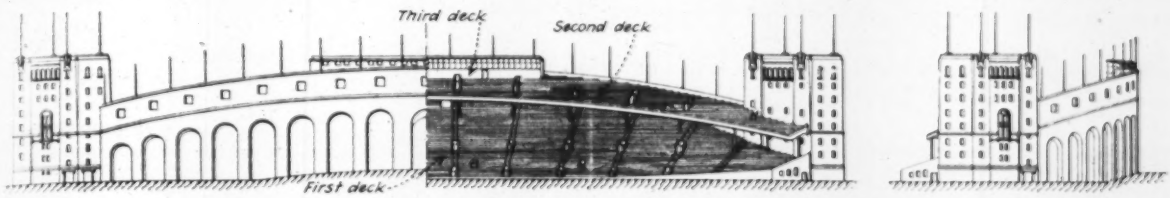


FIG. 3—SKETCH ELEVATIONS OF STADIUM STRUCTURE, NORTHWESTERN UNIVERSITY

service road. Evanston being a considerable materials market, dealer delivery of material, with virtually no job stockpiling, was the most feasible plan and as it worked out speed started at the beginning with rapid and dependable deliveries of material. No stock of any size was maintained on the ground. All gravel, sand and cement came, as required, from the local dealers, the Central Coal & Materials Co., a mile and a half away. This arrangement eliminated piles of material about the job, kept gravel and sand free from foreign matter and afforded supplies as needed. In the dealer's yard were four elevated bins with a total capacity of 40 cars. One of these bins would discharge gravel or sand by gravity into a truck, filling it with six cubic yards in less than a minute. Six minutes later the truck was dumping its load into the boot of the bucket elevator at the job. Drivers made round trips in 14 minutes which included loading and unloading. With this quick service, three trucks were adequate to maintain deliveries.

Concrete Plants Well Outfitted—As shown by the plan the locations of the concrete plants as well as the necessity of separate plants were dictated by the site conditions. Virtually duplicate plants comprising a truck ramp; boot hopper; bucket elevator; bins; batcher and inundator; mixer; mast hoist, and chutes, were installed except in one the mixer was ½ cu.yd., and in the other ¾ cu.yd. One of the views, taken before construction had hidden the plant units, shows the arrangement clearly and in particular displays the 180-ft. masts with their network of guy ropes.

Considering the plant units, the bucket elevator conveyed the aggregates from the boot to the sand and gravel hoppers above the mixer at the rate of about a yard a minute. Each hopper held 36 cu.yd. of six truck loads and provided material sufficient for over seventy ¾-cu.yd. batches of concrete. The inundator insured exact measurement of the sand and gave the water control necessary for good concrete; the batcher furnished the correct amount of gravel; a man dumped in the required cement, and the batch was ready for the mixer—the whole process consuming only about 30 seconds. Each of the seven men in the mixer organization was assigned a particular task. Two of them attended to the aggregates; one operated the inundator, batcher and water tank; one charged and dumped the mixer; two carried cement, and one emptied it. After a full minute's mixing, insured by an inspector holding a watch, the concrete was ready to be placed.

Rapid delivery of concrete to the forms was accomplished by a hoist tower or mast capable of depositing three buckets every five minutes or 27 cu.yd. an hour.

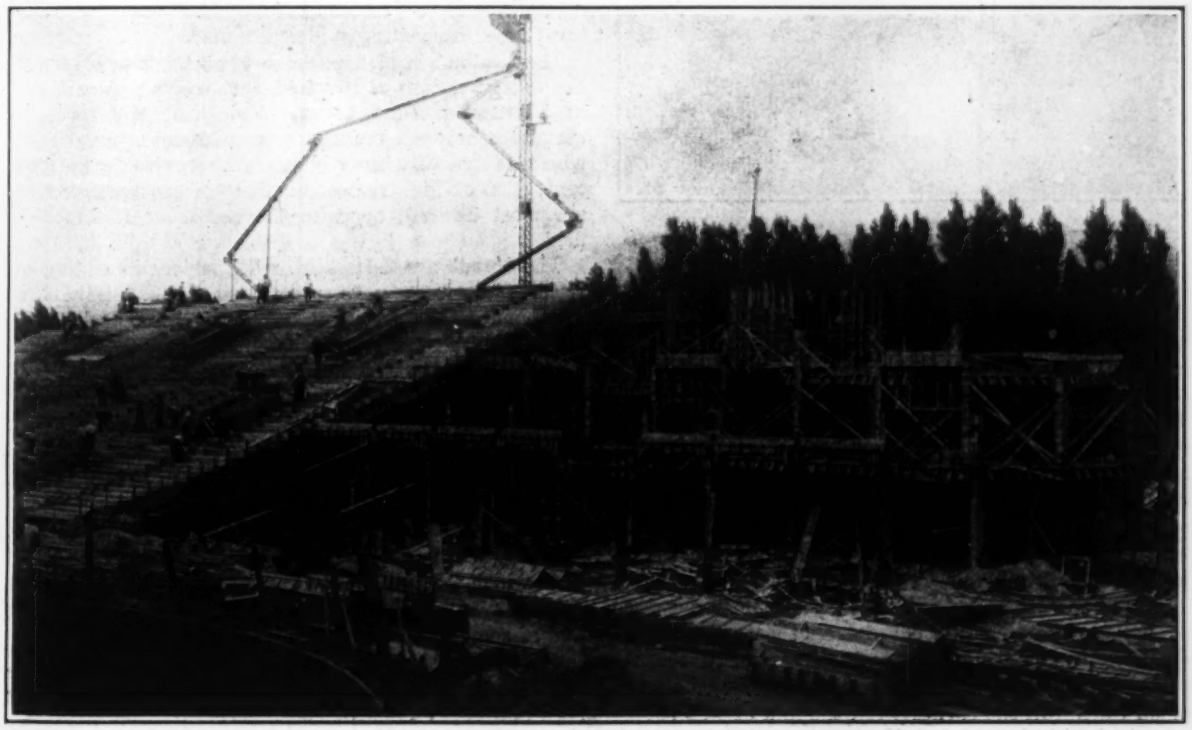


FIG. 4—SPOUTING SYSTEM AND FORM CONSTRUCTION, NORTHWESTERN STADIUM

This quick delivery enabled the workmen to place as high as 318 cu.yd. in a day. The work, however, was mainly slabs and the "day" extended to 11 o'clock at night with big flood lights illuminating the work.

Two types of apparatus took the concrete to the forms. For portions of the work near the tower, short sections of metal chutes, supported on the forms, were used. The concrete was shot from the tower hopper

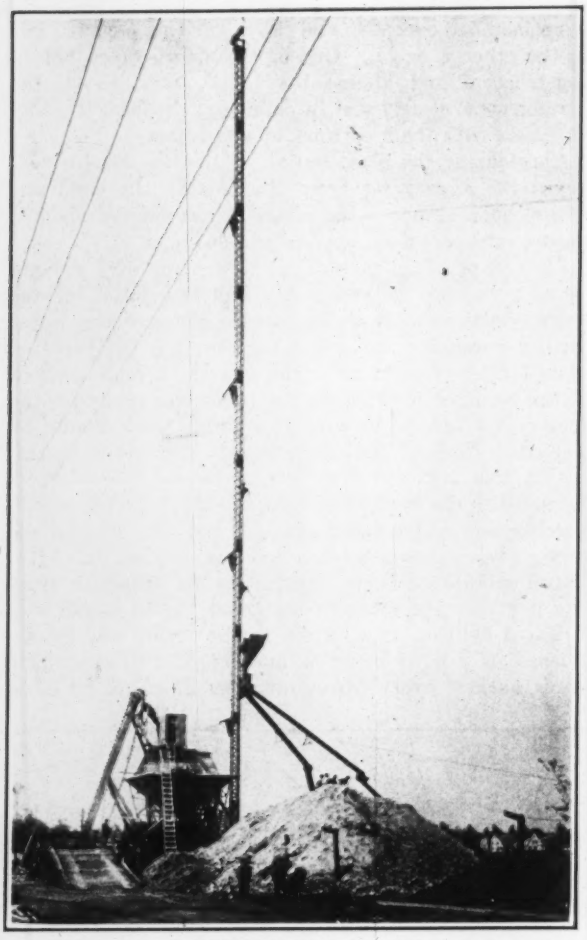


FIG. 5—CONCRETE MIXING PLANT AND TOWER, NORTHWESTERN STADIUM

into a wooden trough from which it flowed through the chutes to the required place. For more remote work it was discharged by the equipment into a hopper and then into buggies and dumped directly into the forms. Inspection of concrete delivered under both systems showed it to be coming through as rapidly as it could be used, thoroughly mixed, of uniform consistency and without separation of ingredients. After a few hours, depending on the temperature, the workmen began sprinkling the exposed surfaces of the concrete and it was kept wet for 10 days to insure proper curing.

Rich Concrete Speeds Work—Time also was gained by the use of rich, high early-strength concrete mixes designed by the contractor, which permitted the removal of the forms and shoring in less than half the usual time. On the earlier work the mix of 1:2.76:3.4 was used with four sacks of cement to a batch, 7½ to 8 gal. of water per sack of cement and with a 6½ to 7½ slump. The gravel was ¼ in. to 1½ in. with a fineness modulus of about 7; the fineness modulus of the washed sand was 3.5 and of the mix 5.3. With this mix the specifications provided that no forms should be stripped until after 8 days and that the concrete should then be reshored for a period of 20 days.

In September when it was apparent that still greater speed was needed if he was to complete the project on schedule and avoid payment of penalties, the contractor designed a new mix that produced, with the regular portland cement that was being used, high-early-strength concrete which, if desired, allowed removal of forms in a week. The only change in the mix was to increase the cement one sack—from four to five sacks per ¾-cu.yd. batch. The amount of water and aggregates and the mixing time remained the same. With this new mix of 1:2.16:2.66 having the same fineness modulus as the former mix, average tests revealed a 7-day strength of over 2,100 lb. or nearly 50 per cent greater than the strength (1,550 lb.) developed by the previous mix. The addition of the one sack of cement per batch, with no other change, cut the time required for shoring more than 50 per cent.

Design Features—The design of Northwestern University stadium contemplates an eventual three-deck structure with an ultimate seating capacity of about 75,000. The foundations and the supporting columns are designed for a three-deck structure. For certain piers, columns, arches, girders and other sections bearing concentrated loads, 3,000-lb. concrete was used. In the remaining work 2,000-lb. concrete was used. The present contract, which involved placement of about 15,000 cu.yd. of concrete, called for about 20,000 seats on the first deck and about 4,500 seats on the second deck of the west side and about 12,000 seats on the first deck of the east side. The entire first decks are of reinforced concrete and the second decks of structural steel supporting a concrete slab.

The stadium in plan resembles two lunes or crescents one on either side of the field, terminating at each end in a massive ramp tower. The wide difference in curvature between the seat rows and the exterior wall, which causes this lunar shape, results also in the concentration of the greatest numbers of seats where they are most desired, opposite the center of the football field.

The treads are 2 ft. 1 in. with a rise, depending on sight lines, varying from 6 in. to 12 in. on the first deck and 13 in. to 15 in. on the second deck. The seats consist of three redwood strips 3x1¾ in. placed 18 in. above the treads. They are fastened to cast-iron brackets which are attached to the concrete by bolts inserted in screw anchors that were concreted in place.

The present height at the center is 80 ft. and at the end towers 100 ft. Two elevators with inside dimensions of 6½x9 ft. will be a feature of the stadium, running, when the structure is completed, to the third deck which will be about 120 ft. above ground. Those elevators will be used by occupants of the press box and of some special private boxes.

James Gamble Rogers, architect, and Gavin Hadden, engineer, both of New York, are associated in the design and supervision of construction of this structure. George F. Baker of the same city is resident engineer. J. B. French Co., Chicago, is the contractor.

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Gasoline Fire Used to Remove Cement Plaster in Reservoir

By E. R. Oden
Waterproof Paint Co., Lankershim, Calif.

THE owners of a concrete-lined storage reservoir near Los Angeles attempted to stop leakage by applying a thin troweled lining of cement over the entire floor. This plan was unsuccessful and the Waterproof Paint Co. was called in to waterproof the reservoir with "Aquatite." The application of this waterproofing, a carbon compound, was begun after workmen had carefully removed as much of the old plaster coat as was loose or could be readily broken or pried off.

WORKMEN BURNING GASOLINE ON RESERVOIR FLOOR
The white areas show original concrete surface from which cement plaster was removed by burning gasoline.

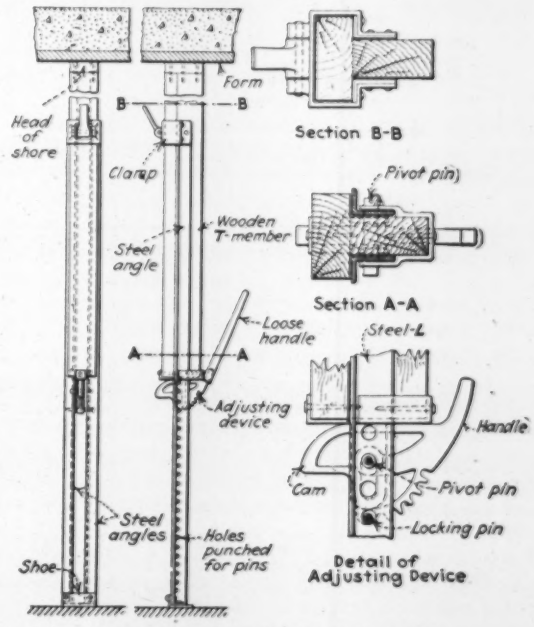
After the completion of a portion of the waterproof coating a few hours in the hot sunshine caused the old plaster beneath to bulge up at various points in the floor. These bulges were considered serious enough to warrant a new beginning and a more determined endeavor to remove all the old plaster.

It was reasoned that if the heat of the sun working on the elastic coating caused upheaval in some places, perhaps this same cause could be intensified in such a way as to remove all of the plaster. Accordingly where the new waterproof coating had been applied it was first removed and then water was allowed to stand on the entire floor for about half a day in order to work under the edges of the cement plaster coating All surplus water was then swept off the floor and a quantity of gasoline was poured quickly over the wet floor and immediately ignited before the liquid had opportunity to work through the cracks into the concrete. The gasoline flushing and firing had to be done on a comparatively small area at a time in order to handle it quickly enough. This scheme was successful and caused the prompt spalling off of about 90 per cent of the old plaster coating. The remainder was taken off by a second firing. The amount of gasoline used was about 1 gal. per 75 sq.ft. of area.

The effect of the gasoline fire may be visualized from the fact that as much as 60 per cent of the cement plaster removed was carried entirely out of the reservoir by the heat and velocity of the burning gases, the material thus lifted was carried to one side by a wind that was blowing at the time, and was deposited in an orange grove nearby. The quick removal of the plaster coat is attributed to the unequal expansion caused by the sudden heat releasing the bond between plaster and concrete floor. The work was done without injury to the old concrete.

Steel and Wood Adjustable Shore

IN A new adjustable shore for concrete construction work, the special feature is the use of a steel lower section spliced to a wooden member, as shown in the accompanying drawing, the parts telescoping and being clamped at any desired position by a cam and lock. This design is claimed to have advantages in simplicity, durability, low cost and ease of adjustment. The wooden member is of the T-section which is very generally used, and the steel member is composed of a pair of angles, between which slides the stem of the T-section. A base piece or shoe is attached to the angles. Holes in the angles provide for setting the adjusting and clamping device at any desired height, with the shoe of the wooden member resting upon this device. In operation, the shore is set up and the wood post is raised till its head engages the form; the clamp is then placed and secured by a pivot pin put through the holes in the steel angles. By means of the handle the cam is rotated in order to raise the wooden member so as to make the final vertical adjustment, the cam being then held by



ADJUSTABLE SHORE FOR FORMS

a locking pin placed through the steel angles and engaging the segmental rack on the lower side of the cam. The cam, handle and rack are all formed in one piece. At the top of the angles is a small eccentric clamp to hold the wooden T-member firmly against any lateral movement.

In a test of the strength of this shore it was set on the pedestal of a steel viaduct post and carried a lever with the shore arm bearing under the girder and with a 300-lb. load on the end of the long arm, the lever proportion being 1:20. No bending appeared until the load was moved up and down to cause impact. This new shore has been designed and built by Howard G. Martin, Grinnell, Iowa, who has patents pending.

Gunite Repair of 36-in. Pipe Line

By Ralph G. Wadsworth
Civil Engineer, San Francisco, Calif.

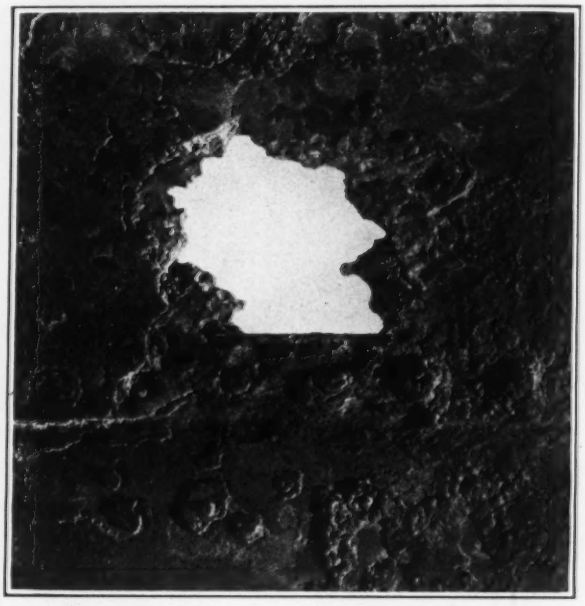
A 36-in. steel pipe line one mile long, which had been rendered unserviceable by electrolytic action, was repaired last year by lining the inside with gunite. The application of this method to a pipe of such small diameter is thought to be unique. Although the difficulties of preliminary cleaning, guniting and removal of "rebound" in the necessarily cramped working space made the labor charges high, the cost of the job was only about half the estimated cost of replacing the line with new pipe.

The line had been constructed of riveted-steel pipe, No. 10 gage, in 1912 to carry irrigation water on a well-developed project in the central portion of the Sacramento valley. Starting from a pumping plant at the Sacramento River, it extended two miles down the slope away from the elevated river channel to the lowest point of the flanking reclaimed flood basin and thence another mile up the gradually ascending opposite slope. At a distance of about one mile from the river it passed under an electric railroad which operates by a third rail. It was buried for its full length at depths of from 2 to 4 ft.

In 1925, after several years of disuse, an attempt was made to put the line into service again but such heavy leakage developed in the portion crossing low ground that benefits of irrigation were more than outweighed by the damage due to flooding and water-logging of a wide strip of land adjacent to the pipe. Further operation had to be abandoned until some method of repairing or replacing the unserviceable portions of the pipe line could be devised.

To determine the nature and extent of the defects, the line was uncovered at 500-ft. intervals, manholes were cut and the interior examined. The man who made the inspection, having been instructed to count, measure and locate all holes or open seams reported after two days of arduous effort that one mile of the line was so riddled with holes of all sizes from a pinpoint up to a man's fist that a count was impossible. It was observed that the corrosion had attacked only the outside surface at concentrated points, all in the portion of the line within the area of low land where the soil had probably been continuously moist for several years due to lack of deep drainage. The accompanying photograph shows the character of one of the larger holes, measuring about 3 in. in diameter, which occurred at a joint between two plates. The original asphalt coating can be observed as still intact in many places and the underlying steel is in general smooth and black, giving practically no indication of ordinary rust. The hole shown was formed in one of the adjoining plates only, the other still showing a straight, uncorroded edge. The edges of the hole have a distinctly terraced angular appearance. All of the evidence indicated that the deterioration of the steel was caused by stray electric currents from the railroad circuit which followed the pipe to the area of moist soil and there returned to the ground.

The plan of welding outside patches, which had been considered prior to the inspection, was immediately abandoned since it was clearly more expensive than new pipe. Comparative estimates were prepared for laying a new line, placing a new slightly smaller steel pipe inside the original, casting a reinforced-concrete jacket around the outside, and lining the inside with gunite. Based on a price for cement gun work equivalent to twice the ordinary cost, the last method still seemed to be only half as expensive as any other and it was believed that the result would be satisfactory if usual methods could be made applicable to a pipe of only 36-in. diameter.



TYPE OF PIPE CORROSION REPAIRED BY GUNITING

The Cement Gun Construction Co. of San Francisco, after several days experimenting on full-sized models, offered to undertake to line 5,200 ft. of the pipe with 1½ in. of gunite for $2.35 per lineal foot and a contract was signed on that basis. The contractor agreed to do all necessary work except cut manholes, which were to be spaced by the owners at intervals of 250 ft.

Cleaning the pipe of mud and debris, removing loose scale, and pumping out seepage water formed a considerable portion of the cost since labor, in poor light and cramped quarters and under difficult supervision, was necessarily inefficient. The procedure in guniting was to "shoot" the sides and bottom first and then the

From Job and Office

Hints That Cut Cost and Time

From Job and Office

For Contractor and Engineer

top. It was found necessary to place the top in two layers. No reinforcement was used except at large holes in the steel. Removal of the rebound after completion of the guniting was effected by scraping to the manholes with a specially constructed drag and shoveling out by hand. The manholes were sealed from the inside as the last operation, the work proceeding progressively from one end to the other.

After the work was well organized, an average of 100 ft. of pipe were lined each 10-hour day with one cement gun. E. F. Halloran, manager of the Cement Gun Construction Co., after finally checking up his actual costs, states that a price of $2.50 per lineal foot would be necessary on future work of the same kind to give a fair margin of profit.

The repaired pipe was operated throughout the irrigation season of 1926 with complete success. In order to arrest continued electrolytic corrosion, it is planned to insert several insulating joints in the line although the gunite shell will resist the low pressures on the pipe even if the outer steel should eventually be removed.

The work described was carried out under the supervision of Fred H. Tibbetts, civil engineer, San Francisco, with the writer in immediate charge.

Simple Wood Brace Holds Curb Forms

By John M. Weed

Columbus, Ohio

THE plans for a short section of concrete paving at Ada, Ohio, called for a curb 6 in. high, 6 in. wide at the top and 7 in. wide at the bottom, constructed integrally with the pavement. The job was too small to justify the buying of expensive forms, so the contractor made use of boards supported by wooden braces.

A half-width of pavement was placed at a time,

CURB FORM BRACE OF SECURELY BOLTED BOARDS

struck off, tamped and belted. When the concrete would support the form board without injury, which was before setting had gone far, the forms were braced in position (the outside board resting on the steel side form) and filled with the curb material. Straight sections of the curb were remarkably straight. Curves at intersections were easily built using flexible boards.

Guy H. Elbin, professor of civil engineering at Ohio Northern University, is the village engineer. E. W. Peterson of Ada was the contractor.

Surface Area of Structural Sections

By R. J. Slater

Engineer, National Aniline & Chemical Co., Buffalo, N. Y.

OF particular interest to building and painting estimators is the chart herewith shown which gives the surface area per lineal foot of standard structural sections. These include I-beams from 3 to 24 in., H-

SURFACE AREA PER LINEAL FOOT OF STANDARD STRUCTURAL SECTIONS

I-BEAMS

SIZE	WT.	TOP FLANGE A	BOTTOM FLANGE B	WEB BOTH SIDES C	FOUR INNER FLANGES D	AREA TOTAL SQ. FT.
24	80	0.5833	0.5833	3.748	1.3854	6.000
20	65	0.5208	0.5208	2.820	1.2050	5.067
18	55	0.5000	0.5000	2.533	1.1510	4.684
15	60	0.5000	0.5000	1.958	1.1510	4.109
12	31½	0.4167	0.4167	1.601	0.9660	3.401
10	25	0.3880	0.3880	1.325	0.9010	3.000
9	21	0.3620	0.3620	1.179	0.8410	2.744
8	18	0.3330	0.3330	1.033	0.7700	2.470
6	12½	0.2780	0.2780	0.744	0.6480	1.950
5	9¾	0.2500	0.2500	0.599	0.5780	1.677
4	7½	0.2210	0.2210	0.453	0.5130	1.408
3	5½	0.1950	0.1950	0.307	0.4500	1.148

H COLUMNS

SIZE	WT.	TOP FLANGE A	BOTTOM FLANGE B	WEB BOTH SIDES C	FOUR INNER FLANGES D	AREA TOTAL SQ. FT.
4	136	0.333	0.333	0.523	0.614	1.804
5	187	0.416	0.416	0.673	0.781	2.288
6	238	0.500	0.500	0.825	0.947	2.773
8	340	0.666	0.666	1.156	1.270	3.920
10	540	0.833	0.833	1.479	1.604	4.749
12	780	1.000	1.000	1.733	1.916	5.649
14	990	1.166	1.166	2.041	2.250	7.610

CHANNELS

SIZE	WT.	TOP FLANGE A	BOTTOM FLANGE B	INNER WEB C	BACK D	TWO INNER FLANGES E	AREA TOTAL SQ. FT.
3	4	0.117	0.117	0.148	0.250	0.234	0.867
4	5¼	0.132	0.132	0.226	0.333	0.265	1.091
5	6½	0.145	0.145	0.299	0.416	0.291	1.299
6	8	0.158	0.158	0.375	0.500	0.317	1.510
7	9¾	0.174	0.174	0.453	0.583	0.349	1.734
8	11¼	0.187	0.187	0.528	0.666	0.375	1.945
9	13¼	0.203	0.203	0.604	0.750	0.406	2.166
10	15	0.216	0.216	0.679	0.833	0.432	2.374
12	20½	0.248	0.248	0.825	1.000	0.489	2.804
15	33	0.283	0.283	1.028	1.250	0.567	3.414

UNITS	AVERAGES
I-BEAMS	
LIN. FT. PER TON WT.	SQ. FT. SURFACE PER TON WT.
25	150
38	156
36	167
33	147
64	216
80	240
95	258
111	267
160	312
205	344
267	363
364	414
H COLUMNS	
LIN. FT. PER TON WT.	SQ. FT. SURFACE PER TON WT.
147	265
107	244
84	233
59	229
37	171
26	144
22	154
CHANNELS	
LIN. FT. PER TON WT.	SQ. FT. SURFACE PER TON WT.
500	434
381	415
308	397
250	375
207	356
178	346
151	327
133	316
98	274
61	208

AVERAGES		
I-BEAMS		
AV. LIN. FT. PER TON WT.	AV. SQ. FT. PER TON WT.	
123.2	252	
H COLUMNS		
AV. LIN. FT. PER TON WT.	AV. SQ. FT. PER TON WT.	
69	206	
CHANNELS		
AV. LIN. FT. PER TON WT.	AV. SQ. FT. PER TON WT.	
226.7	344.8	
GRAND AVERAGE MIXED BEAMS COLUMNS & CHANNELS		
AV. LIN. FT. PER TON WT.	AV. SQ. FT. PER TON WT.	
139	267	

CHART GIVES SURFACE AREA OF STANDARD SECTIONS

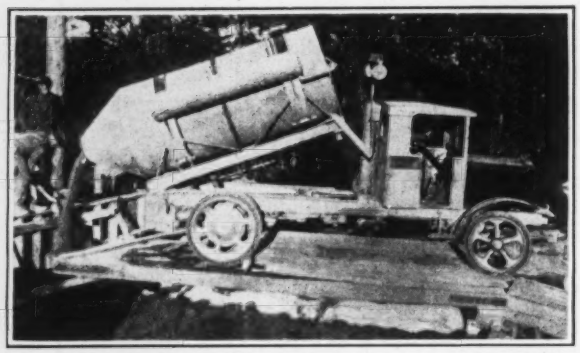
sections from 4 to 14, and channels from 3 to 15. In the case of I-beams, it is found that the average lineal foot per ton of weight is 123.2, the average square foot per ton of weight, 252. For H-columns, these are 69 and 206, and for channels 226.7 and 344.8.

Concrete Mixer Mounted on Truck Does Mixing in Transit

THE combination of concrete mixer and motor truck has been extensively used in Seattle on jobs where the advantage of the central batching plant would be increased by making it possible to do the mixing either in transit or upon arrival at the job. The transit mixer, as it is called, makes it possible to sell concrete from a central batching plant for delivery beyond the distance that would mark the limit of safety with ready-mixed concrete. There is also the advantage that the driver need not add the water and start mixing until after arrival at the job so that if the concrete is not wanted at that time the materials are not lost but can be taken to another job or left in the mixer over night.

The device consists of a large cylindrical steel drum mounted on a truck chassis so that it can be revolved by a power take-off from the transmission, either through chain or gear drive. The inside of the cylinder is equipped with vanes so that a thorough mixing of

the concrete is secured when the cylinder rotates. Both the rotation and the discharge of water from supply tanks to the cylinder are controlled from the driver's seat.



TRANSIT MIXER DELIVERING 3 CU.YD. TO BRIDGE PIERS
The picture shows entire concrete crew on the job; foreman, helper and truck driver.

The transit mixers are manufactured and distributed by the Paris Transit Mixer Co. of Seattle. At present 2 and 3-cu.yd. sizes only are being made but 1 and 1½-cu. yd. mixers are soon to be offered.

Special Carriage Handles Penstock Sections on Steep Slope

By Daniel McFarland
Storrie, Calif.

THE photograph shown herewith pictures a carriage that is in use on the Kings River development of the San Joaquin Light & Power Co. to handle sections of the penstock pipe. The penstock is very steep, having grades up to 119 per cent, which makes any ordinary method of handling out of the question. A track was

CARRIAGE WITH 7-FT. GAGE PLACE PENSTOCK PIPE

built with a 7-ft. gage with its center on the centerline of the penstock line on which the carriage operates.

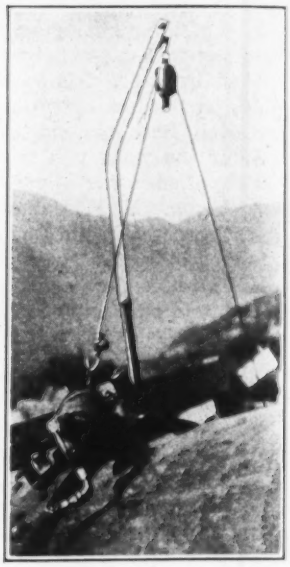
The heavy penstock pipes are rolled between the rails at a level place on the track near the upper end. The car is lowered down until it is directly over the pipe, and the pipe is picked up with four chain blocks.

The two I-beams, one directly over the upper wheel and the other directly over the lower wheel, are removed just before the car is lowered over the pipe and replaced when the grip is picked up.

Both the car and the pipe are fastened to the tackle that lowers them down the penstock line. A hoisting engine lowers the pipe down the line, and by means of the four chain blocks, the pipe is set in position quickly.

Job and Office Notes

A Bucking Up Hammer, shown herewith, was used on the San Joaquin Light & Power Co. penstock on the Kings River development. The rivets are 1⅛ in. round head. The hammer has a cast-iron shell around it to give it additional weight. Because of its weight, a counterweight is used to facilitate handling it. The rod that supports the hammer and counterweight is stuck into one of the rivet holes, and has a shoulder to prevent its going on through. The pipe is 1⅛ in. thick and the butt strap 2 in. thick, so that the rod is held laterally.



Daniel McFarland,
Storrie, Calif.

Using the Principle of Oxy-Acetylene Cutting, an engineer attached to the Bureau of Water Supply of Jerusalem, Palestine, did an ingenious piece of work while depressing a water-supply main. The distribution pipe system of the Bureau of Water Supply was laid in a hurry by the English military and in several places where rock was encountered the pipe was laid without any earth covering. In such places pipe had to be lowered into the ground. As conditions were such that continuous use of the pipe had to be maintained, no blasting was allowed and hand-chiseling of the limestone rock was difficult. Accordingly, A. Palotai, mechanical engineer and an assistant engineer in the Bureau of Water Supply, made a cutting apparatus out of an ordinary big blow lamp fed with paraffin from a small air vessel at a pressure of from 2 to 3 kg. per cu.cm. Thus, the job was made cheaper and accomplished much more quickly than had manual means of chiseling been used entirely. A strong flame was required and the flare had to be surrounded by a sheet-iron cover because the limestone burst with rather violent explosions under the action of the flame.

In Winter Granite-Block Paving at Chicago, it was necessary to prevent the grout filler from freezing. Water was heated in the tar tank and treated with a liberal dose of salt, while the sand was heated in an asphalt plant. Steam and rock salt were used to remove snow and ice from the concrete foundation and from the piles of granite blocks. These methods were described by J. A. Moore, of the Board of Local Improvements, in a paper at the annual meeting of the Illinois Society of Engineers.

Eighteen-Hundred White Crosses have been erected by the Ohio Department of Public Works at the scenes of fatal motoring accidents. The following table shows the percentages of fatal accidents as indicated by these crosses at various typical locations as compiled from the records of the department: Railroad crossings, 30 per cent; turns and curves, 18; hills, 6; road intersections, 7; straight sections of road, 33; bridges, 6. While there is no actual statistical proof that these crosses have decreased the number of fatal motor accidents since their erection the department is firmly convinced that such is the case. The favorable comment that has been received from motorists of Ohio and other states as well as various organizations and publications proves that the crosses have created an impression on the minds of the traveling public. The idea, of course, is not to let the motorist forget that possible injury or death lurks anywhere along the road for him if he drives carelessly or without consideration for the rights of others.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Economic Diameter of Water and Pipe Lines

Sir—When I read the article by J. W. Ledoux in your issue of Feb. 11, 1926, p. 250, it seemed to me that there were some errors in it and I laid it aside for further study. I did not get around to look at it again until recently, when, our classes having been suspended due to the revolution. I have had time for such things. It seemed to me worth while to go somewhat farther into the subject, and I have therefore prepared the following notes which I hope you may think worth publishing.

As Mr. Ledoux points out, the diameter decided upon will depend upon the engineer's judgment in regard to many factors which cannot be treated mathematically. But a mathematical treatment has its value, and should be as accurate as possible. The above article derives the formula

$$d = 32.3\left(\frac{q^2iS}{Hongk^2}\right)^{\frac{1}{5}} \qquad (1)$$

where

d = inside diameter of the pipe in inches,
q = flow in cubic feet per second,
i = value of water energy at the power station in cents per kw.-hr.
S = working tensile strength of pipe in pounds per square inch,
o = cost of pipe in cents per pound.
n = per cent annual interest, depreciation, taxes, insurance and repairs,
g = weight of material of pipe, in pounds per cubic inch,
k = coefficient in Chezy's formula,
H = maximum static head in feet.

This formula also gives the economic diameter of a pipe line where pumping is required if i is then understood as the value of the energy supplied by the pump. Mr. Ledoux states that the economic diameter in the latter depends on the length, but this seems to be due to an error. C_1 and C were interchanged, and the formula for a "pumping main" should be

$$C_1 = \frac{wonl}{10{,}000} + 365\,QmF, \text{ where } C_1 = Cl \text{ and } F = fl$$

Substituting these, and dividing through by l, we get

$$C = \frac{won}{10{,}000} + 365\,Qmf.$$

Q = flow in millions of gallons per 24 hr., $q = 1.547Q$.
m = cost in dollars of pumping 1 m.g. 1 ft. high (or rather that part of the cost which will be affected by changes in the diameter of the pipe). $i = 31.82\,m$.

Substituting these values we get

$C = \frac{won}{10{,}000} + 7.42\,ifq$, as derived for "gravity mains."

If a formula in terms of Q and m is desired, we may substitute in (1) and get

$$d = 63.8\left(\frac{Q^2mS}{Hongk^2}\right)^{\frac{1}{5}} \qquad (1a)$$

These formulas are derived on the assumption that the resistance varies according to the Chezy formula. But more accurate results will be obtained from a formula like the Hazen-Williams, $v = C_1r^{.63}s^{.54}0.001^{-.04}$ which reduces to $s = \frac{852.000\,q^{1.852}}{C_1^{1.852}\,d^{4.8704}}$. Then the loss due to friction, in dollars per year per foot of pipe, will be

$$\frac{62.5 \times 0.001356 \times 24 \times 3.65 \times 852{,}000\,iq^{1.852}}{C_1^{1.852}\quad d^{4.8074}}.$$

The annual cost of the pipe in dollars per foot may be assumed as $\frac{62.5\,\pi\,Hongd^2}{2 \times 12 \times 10^4\,S}$. Adding these two expressions, differentiating with respect to d, equating to zero and solving for d, we get

$$d = 31.3\left(\frac{Si}{Hong}\right)^{.160} C_1^{.37}\,q^{.415} \qquad (2)$$

For riveted steel pipe "where the carrying capacity after a series of years is the controlling factor," King and Wister (Hydraulics, p. 152) recommend $C_1 = 95$. Substituting this in (2) we get

$$d = 9.16\left(\frac{Si}{Hong}\right)^{.146} q^{.415} \qquad (3)$$

The efficiency of the joints will not usually be over 70 per cent and with allowance for water hammer and corrosion, the static stress on the gross area will generally not be over 10,000 lb. per sq.in. Also the denominator of the fraction in formula (3) ought to be increased by about 10 per cent to allow for the extra material in rivets, laps, etc. Instead of changing the denominator we will take $S = 9{,}000$. (For triple riveted joints, where the efficiency is higher, the increase in cost of the joint will tend to balance the saving in the thickness of the shell, and will not change the economic diameter appreciably.) Substituting $S = 9{,}000$ and $g = 490 \div 1{,}728 = .284$ in (3) we get

$$d = 41.4\left(\frac{i}{Hon}\right)^{.146} q^{.415} \qquad (4)$$

When the static head is less than say 50 ft., the thickness of the shell will not be further reduced by reducing the head, and d will be given by the following formula, obtained by substituting $H = 50$ in (4),

$$d = 23.4\left(\frac{i}{on}\right)^{.146} q^{.415} \qquad (5)$$

Substituting $i = 31.82\,m$ and $q = 1.547\,Q$ in these formulas we get

$$d = 62.0\left(\frac{Sm}{Hong}\right)^{.146} C_1^{.37}\,Q^{.415} \qquad (2a)$$

$$d = 18.2\left(\frac{Sm}{Hong}\right)^{.146} Q^{.415} \qquad (3a)$$

$$d = 82.2\left(\frac{m}{Hon}\right)^{.146} Q^{.415} \qquad (4a)$$

$$d = 46.5\left(\frac{m}{on}\right)^{.146} Q^{.415} \qquad (5a)$$

Substituting in (4a) the data $o = 5$, $n = 10$, $Q = 10$, $m = .017$ and $H = 200$, as in the illustration given in the above article, we get $d = 30.7$ in. With $S = 12{,}000$ and $g = .28$, (3a) gives $d = 32.25$ in. With $k = 100$, (1a) gives $d = 31.6$ in. This shows that basing the estimate of frictional resistance on the probable value after some years increases the diameter over that given by Mr. Ledoux's formula, but that this is more than made up by the lower unit stress which we have assumed, so that (4a) gives a slightly smaller value than (1a).

It is believed that formulas (4), (4a), (5), and (5a) are somewhat more accurate than (1) and (1a), especially in the values of the exponents. In this connection it is interesting that Turneaure and Russell in their "Public Water Supplies," p. 605, derive a formula for the economic diameter of cast-iron pipe in which the exponent of the cost term is .16 instead of .146 as found above. The reason is that we have assumed the cost of pipe to vary as the square of the diameter, while they found by study of actual cost data, that the cost of cast iron pipe in place varies as the 1.55th power of the diameter. A study of similar data for riveted steel pipe might show something of the same sort.

RALPH W. POWELL,
Associate Professor of Applied Mathematics,
College of Yale in China.
Changsha, China,
Jan. 15, 1927.

Sir—Concerning the letter from Professor Powell [printed above] criticising an article by me, I have checked the calculations and reasoning in this article, and feel sure they are correct.

The formula occurring in the second column is correct:

$$l = \frac{d^4 + a}{bd^2}$$

There is an obvious error, however, in the last formula, which should have been

$$l = \frac{d^4 - 31{,}260{,}000{,}000}{288.6\,d^2}$$

The table, however, is correctly worked out from the correct formula.

I believe Professor Powell is not justified in his criticism, in stating that d is not dependent upon l. Evidently, d depends on every one of the factors occurring in the second column, and certainly on the values of l, H and Q.

I am not in accord with Professor Powell's assumption that the annual cost varies as the square of the diameter, or any other function of the diameter, which enables him to eliminate the cost factor and determine the minimum value of the diameter directly. It is more logical and easier understood to determine the minimum cost.

I do not object to his using Hazen & Williams pipe formula, which is more accurate in form than the well-known Chezy's formula, but the latter is simpler and sufficiently accurate for purposes of this kind, especially as in either case it is necessary to give an arbitrary value to the coefficient C, which may vary between wide limits, say from 100 to 130, depending on the quality of the pipe's interior and other factors. Great accuracy is unnecessary when the premises do not warrant it.

J. W. LEDOUX,
Consulting Engineer.

Philadelphia, Pa.,
March 11, 1926.

Danger in Pit-Run Aggregate

Sir—Professor Griffith's article on "Proportioning Pit-Run Aggregates in Concrete," which appears in the March 10, 1927, issue of *Engineering News-Record*, seems to the writer to be another unfortunate example of dignifying admitted approximations by expressing them in terms of exact formulas, without regard to practical considerations involved in their application.

It is not, however, Professor Griffith's mathematics on which we wish to comment, but on the method of proportioning pit-run aggregates described by Mr. Crum in the 1919 "Proceedings" of the American Society for Testing Materials, which Professor Griffith uses as the basis of his article. The method referred to purports to furnish an accurate means for proportioning haphazard materials but takes for its fundamental assumption something that does not exist—a reasonable degree of uniformity in pit-run aggregate.

It seems to the writer that any description of a procedure for proportioning concrete using unprepared run-of-bank materials is apt to leave an erroneous impression in the minds of those not thoroughly familiar with the fundamental principles of concrete mixtures, unless the pitfalls and lack of economy of using such materials are emphasized. While pit-run aggregates consisting of clean and durable particles can be proportioned in the laboratory in such a manner as to produce satisfactory strengths, it is extremely difficult to control their proportions in the field to obtain, consistently, concrete of the quality desired.

Pit-run aggregates are characterized by the following features which make them unsuitable for use in concrete work where any dependence is to be placed on uniform quality:

1. Poor grading.
2. Poor uniformity in grading.
3. Presence of harmful impurities.

It will be recognized at once that the use of poorly graded aggregates increases the amount of cement required, the most expensive ingredient of concrete, and that variations in grading would require constant changes in the proportions to maintain a uniform quality of concrete. The economical operation of any job depends on the establishment of a routine. Even if it were possible to anticipate changes in grading of unprepared materials, and it is not, it would be impossible to establish a satisfactory routine where changes in grading were constantly occurring. The presence of harmful amounts of organic impurities in an aggregate should, of course, at once eliminate it from consideration for concrete work. It is a rare deposit of sand and gravel which does not require washing to make it suitable for concrete. The strength of concrete may be reduced as much as fifty per cent by the presence of organic impurities in such minute quantities that they cannot be detected by visual examination.

Mr. Crum was not altogether unmindful of these handicaps in the use of pit-run materials, but nevertheless he does not, in the opinion of the writer, emphasize them sufficiently, and Professor Griffith ignores them entirely. In Mr. Crum's paper it is stated: "The principal difficulty is the fact that the product of a pit is often extremely variable as regards grading." In Mr. Crum's closure to the discussion which accompanies the paper in the A.S.T.M. "Proceedings," he says that he "wishes to make it clear that he is not advocating the use of pit-run gravel in place of washed and screened aggregate in general concrete construction." We sympathize with this viewpoint and wish that it had been given greater emphasis in the paper.

Much could also be said concerning the accuracy of the method proposed by Mr. Crum for proportioning concrete. It is sufficient to point out at this time, however, that the method takes into account the proportion of fine and coarse aggregate without regard to the grading of either the fine or coarse aggregate, except by means of the unit weight of the material. While there is, undoubtedly, a close relation between grading and unit weight of aggregate, that relation is not such that it can be used to predict the concrete-making properties of an aggregate. The method also neglects consideration of the quantity of mixing water required; certainly a most important factor. There would seem to be no doubt but that any generally applicable method must give consideration to the grading of both the fine and coarse aggregate and also to the quantity of mixing water.

STANTON WALKER,
Director, Engineering and Research Division,
National Sand and Gravel Association.

Washington, D. C.,
March 15, 1927.

Figuring Velocity of Approach in Dam Design

Sir—A review of of several recent texts, dealing with the design of masonry dams shows that it is becoming almost universal to discuss as one of the forces acting on a dam the kinetic pressure due to velocity of approach. One book indicates that the pressure against a dam 10 ft. high may in this way be increased by 10 per cent of that due to static forces alone. Most of the texts, however, explain that the effect is "seldom" large. The matter is not very important, except that the conception is becoming one of the "established facts" of engineering by virtue of repeated copying and thus represents so much additional meaningless burden on the literature.

One book says this head is "somewhat less than" $v^2/2g$, a second gives v^2/g, a third gives a value which seems to be equivalent to Vv_1/g, where v is the velocity of approach in each case and v_1 is the velocity over the crest. There is also difference of opinion as to where the resultant force is applied. All three of these books seem to agree that the kinetic head is to be added to the head of the pool above the dam.

The water immediately back of the dam is not in motion downstream at all and the pressure of this water against the back of the dam has at any point an intensity wh, where h is the distance to the water surface at the back of the dam and not in the pool above the dam. This head on the dam is in nature affected by the velocity of approach and any computation or assumption as to the expected head is presumed to include this and all other effects. Theoretically the head over the crest for a given discharge seems to be decreased, not increased, by the velocity of approach.

These textbooks, therefore, indicate the wrong head in discussing the pressure on the back of the dam, increase this head for velocity of approach whereas the effect of this velocity is to decrease the head, and disagree as to the theoretical amount to be added and its point of application. Of course the maximum head above the dam crest cannot be accurately foretold; in any case the effect of velocity of approach is small and is decreased by eddy losses. The added burden is not on the dam but on the student.

A case similar in some respects is presented by the added pressure on bridge piers due to the current, referred to in some texts. There is such a pressure, as indicated by the difference in water level above and below the pier, but this difference is not $v^2/2g$ because of the large eddy losses in this case and also is not the same as the backwater superelevation, because there is a depression of water level below the pier as well as a backwater elevation above. The value depends on the characteristics of the crossing and the shape of the pier.

HARDY CROSS,
Professor of Structural Engineering,
University of Illinois.

Urbana, Ill.,
March 12, 1927.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

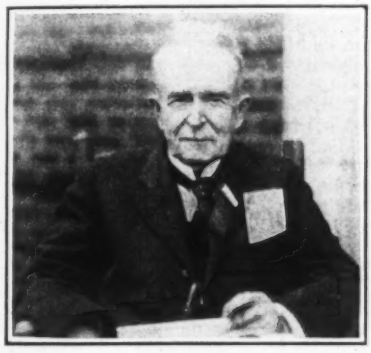
W. O. Winston Dies at Los Angeles

Past President of A.G.C. Had Been in the Contracting Business Continuously 52 Years

W. O. Winston, past-president of the Associated General Contractors of America and one of the pioneer railway contractors of the West, died on March 15 at Los Angeles, Calif. Mr. Winston was 74 years old and had been in the contracting business continuously since 1875. He was born Feb. 6, 1853, at Courtland, Hanover County, Va., and was educated at private schools.

In the summer of 1872 he took his first position, a place with an engineering party of the Chesapeake & Ohio Ry. Co., where he remained until the winter of 1873-1874. On May 1, 1874, he left Virginia for Minneapolis, Minn., where he entered the construction business with his two brothers in the fall of 1875, after having spent the intervening time with a government engineering party.

W. O. WINSTON



Photograph taken at Asheville, N. C., at the annual convention in January, 1927, of the Associated General Contractors of which the veteran contractor was, as past-president, ex-officio a member of the board of directors.

Business was carried on under the firm name of Winston Brothers until the death of the eldest brother, P. B. Winston, following which the organization was incorporated in March, 1902, under the name of Winston Bros. Co. F. G. Winston was elected president, and W. O. Winston, vice-president. The incorporation of a subsidiary company of Winston Brothers Co., under the name of Winston-Dear Co., took place in 1903, and W. O. Winston was named vice-president. In 1905 he was elected president of Winston-Dear Co., a position which he held until his death. On the retirement from active business of his brother, F. G. Winston, he was elected president of Winston Brothers Co. in March, 1914. In April, 1921, he resigned as the president of Winston Brothers Co., and was made chairman of its board of directors.

Forty-one Millions Approved for Rivers and Harbors

The Secretary of War has approved rivers and harbors projects totalling in number 263 and in appropriations $41,638,833. The distribution of appropriations which the Secretary has just approved is recommended by the Chief of Engineers, United States Army. The projects which draw appropriations of $500,000 or more are as follows:

Ohio River, $8,500,000 of which $250,000 is for open-channel work, and the rest for lock and dam construction; Mississippi River between Ohio and Missouri, $3,000,000, and between Missouri River and Minneapolis, $2,000,000; Delaware River from Philadelphia to the sea, $2,000,000; Missouri River from Kansas City to the mouth, $2,000,000; New York and New Jersey channels, $1,700,000; Allegheny River, lock and dam construction, $1,500,000; Hudson River, $1,200,000; Los Angeles harbor, $1,000,000; Sabine-Neches Waterway, Texas, $800,000; Coos Bay, Oregon, $750,000; East River, New York, $700 000; Savannah Harbor, Ga., $700,000; Milwaukee Harbor, $650,000; Miami Harbor (Biscayne Bay) $630,000; Norfolk to Beaufort Inlet, N. C., $550,000; Jamaica Bay, N. Y., $500,000; Houston ship channel, Texas, $500,000; and Hilo Harbor, Hawaii, $500,000.

U. S. Supreme Court Upholds Minneapolis Zoning Law

Acting on the authority of previous decisions and without a written opinion, the United States Supreme Court, March 21, upheld the constitutionality and validity of the zoning ordinance of Minneapolis, thus sustaining the decisions of the Minnesota state courts in the suit of Charles B. Beery against James G. Houghton as inspector of buildings of Minneapolis. Beery had sought a writ of mandamus in the state courts to compel the building inspector to issue him a permit for the erection of a four-family apartment house in an area where such structures were barred by the city zoning ordinance of 1924. He claimed that the effect of preventing him from erecting a building of this type was to deprive him of property without due process of law and otherwise to violate constitutional rights. The state courts upheld the ordinance and its application to this specific case as being clearly within the police powers of the municipality and as authorized by a state law. This decision was affirmed by the United States Supreme Court.

Los Angeles Flood Control Plans Reviewed

Consultants Find "Poor Engineering" as to Co-ordinated Plan for San Gabriel Project

The board of three engineers, F. H. Fowler, C. D. Marx and C. H. Paul, retained to review and report on the Los Angeles county flood control plans as announced in *Engineering News-Record*, Jan. 6, 1927, p. 35, submitted its report on March 21. A telegram from Los Angeles to this journal gives the following excerpts from the findings.

The consulting board's conclusions favor the Forks site proposed by the county flood commission rather than the Granite Dike site advocated by Pasadena, but it recommends a reduced capacity reservoir at the site for the San Gabriel dam. Holdover storage is not considered feasible. Total storage of 180,000 acre-ft. is recommended to be separately allotted as follows: 5,000 acre-ft. to debris, 70,000 acre-ft. to conservation and spreading controlled by gates and 105,000 acre-ft. for floods controlled by gateless flood ports above El. 1,615. The height of the dam would be 385 ft. above the stream bed. The estimated cost of this project, according to the consulting board, would be $25,800,000. Other county flood-control projects now built or contemplated need replanning, in the opinion of the board. San Dimas dam now is of no use for flood control. The spillways at both San Dimas and Puddingstone need enlarging and the Santa Ana dam is of doubtful value. Revision would be required of both the Big Dalton and Thompson Creek plans and the board believes that Eaton and Sawpit dams are not economically justified.

The report of the board concludes as follows: "The Board of Supervisors in the opinion of the consulting board has suffered from poor engineering advice as to a co-ordinated plan for the San Gabriel flood control project. Large sums have been expended which in our opinion could have been used to much better advantage. By proper engineering and economic studies of future plans before construction is undertaken a repetition of such mistakes may be avoided."

Railroad Projected Into Pulpwood Area in Ontario

A railway is planned for construction this year into the heart of the pulpwood area east of Nipigon, Ontario, to tap the limits of the Thunder Bay Paper Co. and to connect directly with the company's terminals at Port Arthur, a distance of 30 miles. Survey work has already been done, and the laying of steel will be commenced as soon as practicable.

I. C. C. Rejects Ironton Consolidation Plan

Finds Sale of D. T. & I. R.R. to Smaller Line Not Permitted Under Consolidation Law

The proposed acquisition by the Detroit & Ironton R.R. of the properties of the Detroit, Toledo and Ironton and the Toledo Detroit R.R. Co. has been forbidden by the Interstate Commerce Commission on the ground that it may not be accomplished under the present provisions of the Interstate Commerce Act relating to railroad consolidation.

The proposition considered by the commission was that of the Detroit & Ironton, a comparatively new corporation controlled entirely by the Ford interests, to acquire the property of the main road of the Ford group, the D. T. & I., which is controlled by, but not entirely owned by the Ford interests, or to consolidate the properties under the management of the D. & I. The sale of the D. T. & I. to the D. & I. would eliminate the minority stockholders of the former and place the railroad property entirely within the control of the Ford interests.

The commission ruled that it had no authority to grant permission for such a complete consolidation of the two properties at the present time and it recommended that if unified control and operation seem desirable, the D. T. & I. should submit application for authority to lease the property of the D. & I.

In view of its decision that the consolidation was contrary to the present law the commission did not pass upon the contract of sale of the D. T. & I. to the D. & I. in which the minority stockholders not approving of the sale would have been eliminated by being compelled to accept cash for their securities.

N. J. Engineers and Surveyors Hold Annual Meeting

Resolutions asking the New Jersey Legislature to continue its support of the state license law and asking for the passage of Assembly Bill 290 requiring licensed land surveyors to maintain a place of business and display a sign "Licensed Land Surveyor" were adopted at the annual meeting of the New Jersey Society of Professional Engineers and Land Surveyors held March 16 at Newark. Some opposition existed to a provision of bill 290. State, municipal and industrial engineers who are engaged in land surveying as a side line would be forced to discontinue this practice unless their business warranted maintaining separate offices. Opinion was also expressed that this provision should also apply to professional engineers. The New Jersey license law became effective in April, 1923.

Resolutions approving the schedules of fees prepared by the various chapters of the society and applicable to each particular county or district in the state, were adopted. Engineers or land surveyors engaged in work throughout the state were also asked to use the minimum schedule of fees in effect in the locality in which work was being done. All of the schedules will be prepared for distribution to the society membership.

Previous to the Newark meeting the members of the society were guests of the New York Telephone Co. on a visit to the largest telephone building in the world, 140 West St. After a buffet luncheon and an illustrated lecture on photo-telephony, the building was inspected.

The day's program came to a close with a dinner in the evening at the Elks Club, at which the Honorable A. Harry Moore, Governor of New Jersey was the principal speaker. The next annual meeting of the society will be held at Atlantic City.

Peter Daly, civil engineer and surveyor, North Bergen, was elected president; the other officers elected are 1st vice-president, Fred A. Reimer, consulting civil engineer, East Orange; 2nd vice-president, John T. Fallon, Elizabeth; secretary-treasurer, Col. Hugh A. Kelly, re-elected. The members of the Board of Directors for three years are: H. V. Van Emburgh, Plainfield; R. L. Bentley, Newark; Russell S. Wise 2nd, Clifton; Henry J. Sherman, Camden.

Engineering Fifty Years Ago

From *Engineering News*, March 24, 1877

CHIEF Engineer Campbell of New York City in a report for the fourth quarter of 1876, relating to the Croton water supply, states that the present aqueduct has a capacity of daily supply of about 95,000,000 gal., which together with that stored in the city reservoirs is amply sufficient for the demands of the present population, and with proper guard against waste, will serve for some years to come. Assistant Engineer Benjamin S. Church reports the conduit in excellent condition in consequence of the repairs which were made during the season of drought last year, and the chief engineer considers that as the conduit has stood for 35 years uninjured there is no immediate cause for apprehension.

Twenty-Six A.S.T.M. Committees Meet in Philadelphia

Following out a plan instituted some years ago, meetings of committees of the American Society for Testing Materials were held in Philadelphia, March 15-18. Some 26 committees and subcommittees met during the three days. Reports of the meetings given out by the society indicate that practically all the work was in the development of committee activities and the preparation of reports and specifications to be submitted at the annual meeting to be held at French Lick next June.

Planning Board Authorized for N. Y. Towns

Map Alterations and New Subdivision Plats to Be Reviewed Before Official Acceptance

Authority to adopt and amend official plans for streets, highways and public parks and to appoint planning boards are given to town boards in New York State by Chap. 175 of the Laws of 1927, which has been signed by the governor. The law is limited in its application to areas outside incorporated cities or villages. Such planning boards would also have power, if so authorized by their respective town boards, to approve plats for new streets and subdivisions and in connection therewith to approve or modify zoning regulations applicable to the territory involved. Alterations in an official town map, proposed by the town board, would be subject to report by the planning board before final action, but no planning board would have more than 45 days for the purpose.

Planning boards would have the right to make such studies and recommendations relating to the planning and development of their towns as they saw fit, and to employ clerks, experts and a secretary, so long as they kept within the appropriation granted them by town boards. No plot of a subdivision of land, showing a new street or highway outside an incorporated place, can be filed or recorded with the county clerk or register until it has been approved by the proper town planning board, but action in these matters is subject to court review, which may also be had by persons who protest against any decision of a planning board concerning the zoning regulations applicable to such land.

The act contains provisions against the erection of buildings in mapped streets, subject to special permits under stipulated conditions. It also prohibits the construction of a public sewer or other municipal street utility in any street or highway not on the official town map, or the granting of a permit for a building which would not be accessible by a street on the official map; but applications of both these provisions are subject to the judgment of boards of review or similar bodies where such exist to hear zoning appeals.

Bill for State Plumbing Code Before Illinois Legislature

A bill providing for a state plumbing code has been introduced in the Illinois Legislature. The proposed code sets forth basic principles which are in substantial accord, states H. F. Ferguson, chief sanitary engineer, Illinois Department of Health, Springfield, Ill., with the Hoover Committee plumbing report. The bill provides that detailed rules and regulations in agreement with the code shall be prepared by the department named. If the bill is enacted the Illinois model plumbing ordinance, adopted in 1919 and revised early in 1927, will probably serve as a guide in framing the rules and regulations just mentioned.

Washington, D. C., Speed Limit Provision Upheld

In a writ of error to the Police Court of the District of Columbia the Court of Appeals upheld the validity of Section 5k of the traffic regulations of the District of Columbia, prohibiting the operation of a passenger vehicle at a greater rate of speed than 15 miles an hour on certain bridges of the district.

The District of Columbia Traffic Act passed by Congress March 3, 1925, provides for the appointment of a director of traffic and fixes the maximum speed limit at 22 miles per hour for all motor vehicles operated on any highway in the district, except in such outlying districts and on such highways as the director may designate and prohibits the operation of any motor vehicle recklessly or at a rate of speed greater than is reasonable or proper, having regard to the width of the public highway, its use and the traffic thereon, or as to endanger any property or individual.

The original defendant was charged with operating a passenger vehicle at a speed greater than 15 miles per hour on a bridge on which the speed limit was fixed by the director in the regulations. An appeal was made on the grounds that the congressional act authorized a speed limit of 22 miles per hour in all parts of the district, but the court held that Congress did not intend a uniform speed law when it prohibited reckless, unreasonable or dangerous driving within the limit.

Propose $12,000,000 Toll Bridge for San Pablo Bay, Calif.

The Richmond-San Rafael Bridge Co. has filed articles of incorporation with the secretary of state at Sacramento, Calif., as first step in the construction of a proposed $12,000,000 vehicular bridge across San Pablo Bay from Point San Pablo on the Contra Costa side to San Pedro Point on the Marin shore. The structure would be about 14,600 ft. long and would have a vehicular roadway 30 ft. wide. The ship channel would be under two spans giving the necessary width at a clearance of 135 ft. The construction period is estimated at four years.

Notices of intention to make application for 50-year franchises for the bridge were filed with officials in Marin and Contra Costa counties by Roy O. Long. Charles Derleth, Jr., dean of the college of engineering, University of California, is named as designer.

New York City Lets Another Subway Contract

The Board of Transportation of New York City on March 16 awarded to the Slattery Engineering and Construction Co. a contract for the construction of another section of the city's new subway system under Broadway from 173rd St. to 177th St., at the bid price of $1,403,362, the lowest of fourteen bids received. The section awarded will constitute spur tracks for switching back the express train service. It will have four tracks leading from the two express tracks.

This award brings the total number of sections of the city's new subway system now under contract up to twenty-seven and the total amount of contracts awarded $140,434,026. Ground was broken for the city's new subway system two years ago (March 14, 1925) at 124th St. and St. Nicholas Ave. The two sections of subway on which work was then started are now 88 per cent finished. The five sections along Central Park West awarded in 1925 are now 65 per cent completed; the eight sections of the Washington Heights routes along St. Nicholas Ave., Broadway and Fort Washington Ave. which were awarded in 1925 are now 78 per cent completed and the section along lower Eighth Ave. awarded in November, 1925, is now 42 per cent completed, making the average completion for the sixteen sections awarded in 1925 approximately 72 per cent.

Air-Right Buildings for Chicago

Two important buildings are to be erected over railway tracks in Chicago, thus utilizing the air rights over railway property. Both of them will be on the far side of the river. A 12- or 16-story dry goods warehouse for Marshall Field & Co. will occupy the site of the old passenger terminal of the Chicago & Northwestern Ry. at Kinzie St., this company having acquired the air rights from 23 ft. above water level, while the ground floor will be utilized as a railway freight station. For its terminal switching the railway is already introducing oil-engine locomotives and electric locomotives, so that the smoke and ventilation problem is minimized. This building, to cost about $15,000,000, will be set back from the river to permit the future construction of a river-front drive. It will take the place of twelve warehouses now maintained by the company in different parts of the city, thus concentrating its business. A large printing establishment and general office building is to be built for the *Daily News* over the north approach of the new Union Station, north of Madison St. and fronting on the river and Canal St. As steam locomotives are used, large ventilation stacks will be carried up through the building.

Short Railway to Be Built in Pennsylvania

The Interstate Commerce Commission has authorized the Chartiers Southern Ry. to extend its railway line from near Mather, Pa., in a general southwesterly direction, to Waynesburg, a distance of 7.6 miles, all in Greene County, Pa. The purpose of the new line is to make Waynesburg accessible by standard-gage railway and also to open up a large coal-mining area. The estimated cost of the railway is placed at $1,742,000. Construction is to be started before July 1, 1927, and to be completed before 1930.

The Chartiers Southern Ry. is owned jointly by the Pittsburgh, Cincinnati, Chicago & St. Louis, the Pittsburgh & Lake Erie, and by the Baltimore & Ohio Railroad Co., and is operated by the Pennsylvania Railroad Co.

International Testing Materials Congress to Be Revived

The American Society for Testing Materials has announced that the Dutch and Swiss Associations for Testing Materials, acting upon an agreement reached at an international conference on materials held last September in Zurich, have issued invitations to an International Congress for Testing Materials to be held Sept. 12-17, 1927, at Amsterdam, Holland. The old International Association for Testing Materials had its last meeting in New York City in 1912. It was to have had its next meeting three years later, in 1915, at St. Petersburg, Russia, but the war intervened and the association passed out of existence.

The executive committee of the American Society for Testing Materials has accepted, on behalf of the society, the invitation that has been extended to the society and its members to participate in this new congress, and it is planned to have one or more official United States delegates to the Congress and in addition to arrange for the presentation of reports and papers upon some of the topics announced for discussion.

T. D. Lynch, manager, materials and process engineering department, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., is chairman of the committee in charge of plans for the participation of this country in the congress.

Mayors to Meet in Chicago to Study Traffic

Consideration of problems of traffic management from an executive standpoint will bring together on April 13 and 14 many mayors of American cities, a conference sponsored by the National Automobile Chamber of Commerce. The conference will include all phases of street transportation. The particular reason why Chicago has been chosen as a meeting place is because that city has recently completed an extensive traffic survey, and a modern double-deck highway.

The preliminary program includes papers and discussions on uniform traffic control, traffic survey methods, signals and signs, essentials of the program, how to get the city plan into effect, metropolitan planning, garages for parking, how to handle parking, and the enforcement end of traffic.

Enlarge Mining Building at University of Nevada

The Mackay Mining Building of the college of engineering, University of Nevada, at Reno, Nev., is being enlarged so that its capacity for students and its laboratory facilities will be very much increased. Although the total enrollment at the university is somewhat lower than usual, the civil engineering department has about the same number of students as usual. The reduction in numbers is mainly in the electrical, mining and mechanical engineering departments, the first of which has always the largest enrollment.

Washington Notes

THE most serious loss of Bureau of Reclamation funds which resulted from the filibuster in the Senate was the $300,000 for the pumping plant on the Okanogan project. This plant is badly needed. The failure of the appropriation bill means a delay of at least nine months in its construction. Another item lost was the $500,000 for the continuation of construction on the Riverton project but there the government will be the chief loser.

What would have been a very serious loss was the $70,000 for levee work on the lower Colorado but that work falls in the emergency class and a deficit may be created. For that reason the work of strengthening the levees will not be delayed. The general appropriations for the Bureau were slightly larger than those for the current fiscal year but this is due largely to the appropriation of $2,000,000 for the Kittitas project. Plans there had progressed to the point where a large amount of construction work can be undertaken there next year. The long-sought funds for economic studies also were made available. The regular appropriation bill, which was passed and became a law, carries $100,000 for that purpose.

Another bill which became a law extends the authority of the Rio Grande Commission to gather such information concerning the Colorado River as may be necessary for the drafting of a treaty relative to the use of its waters. The act authorizes $50,000 for the study but it was passed too late in the session to secure the appropriation. It will be possible, however, for the commission to do a limited amount of work. A meeting will be held May 2 in Yuma or El Centro. The members of the commission are: Dr. Elwood Mead, commissioner of reclamation; W. E. Anderson, of San Benito, Texas; and Maj.-Gen. Lansing H. Beach, former chief of engineers. Miss Mae Schnurr is secretary to the commission. Mexico has promised to name its members of the commission but as this is written the appointments have not been announced.

WITH its three members in attendance the Federal Power Commission on March 15 voted "that for the present, no action will be taken on any applications on any project on the Clinch River on account of the bearing such action might have on the utilization and disposition of Muscle Shoals."

While no mention was made in the resolution of the commission of the upper Tennessee and its tributaries other than the Clinch, the action of the commission is regarded as padlocking the whole Tennessee River to await the disposition of the government's properties at Muscle Shoals.

The action of the commission was taken during the visit in Washington of the Joint Water Power Committee of Tennessee legislature. The feeling of several of the members of the committee is that it is an unfair exercise of federal power for the government to hold up development on the upper river so as to insure to it the highest possible return on its Muscle Shoals investment, and to reserve for Muscle Shoals power markets which otherwise might be secured for the up-river power plants.

Quantity Surveyors to Meet

The second annual convention of the American Institute of Quantity Surveyors will be held in Washington, D. C., June 6-8. At this convention the progress made by the organization during the past year and its future activities will be discussed. A program of the Institute's sessions will be issued prior to the convention, which sessions are open to any one interested in the construction industry.

The Institute was organized in June, 1926, at Chicago, and since its organization the membership has doubled. The headquarters of the Institute are 510 North Dearborn St., Chicago, Ill., and the secretary is C. T. Burman.

Mexican Railway Electrification to Be Extended

Plans for the extension of the electrified zone of the railway between Mexico City and Vera Cruz have been completed by the Mexican Railway Co. They call for a 22-mile extension eastward to Paso del Macho, giving a total of 70 miles of electrified track in the section which has the worst grades of the entire line, grades which run as high as 5.25 per cent with an average of 4.7 per cent for about 25 miles, the remainder being from 2 to 3 per cent. The electrical work is to be done by the International General Electric Co.

Western Society Holds an Aviation Meeting

Air transport for Chicago was the subject selected for the sixth annual spring conference of the Western Society of Engineers, held March 15, with an attendance of about 125. Owing to the small attendance at previous meetings and the difficulty of securing attendance at day sessions, the conference this year was limited to one session, beginning at 4 p.m. and taking a recess for dinner. In a review of aviation in America, William P. McCracken, U. S. assistant secretary of commerce for aeronautics, advised that early provision should be made for adequate landing fields in view of the rapid development of commercial aviation. The needs of Chicago in this respect were outlined also by P. G. Kemp, chairman of the aero commission appointed by the city council, while present and prospective features of mail transport by air were reviewed by D. B. Colyer, superintendent of the U. S. mail service. Aircraft design and manufacture was the subject of a paper by J. P. Van Zandt, of the Stout Metal Airplane Co., showing that ability to handle the increasing traffic must depend upon an adequate supply of reliable aircraft.

Random Lines

Reminiscenses of a Draftsman

BY ELLDEE

Today somehow, our thoughts go back
To those bleak days alas, alack,
When first we climbed a drafting stool
To sling the ink and swing the rule,
The angle and the old T-square—
To earn our beef stew and carfare.

The work was new and we were scared,
And consequently, sadly fared.
Our fingers were so many thumbs,
Our brain fell down on doing sums
And we made blots and blots galore:
Mere memory of which makes us sore!

And oft and oft our breeches ripped
As we toiled with the "Reinhardt"
script;—
That nifty draftsman's alphabet—
The finest letter ever met—
That adds the last touch to a plan
When rightly made—s' 'elp us Ann!

And how our wishbone ached and
throbbed
As up and down we bobbed and bobbed
With deep drawn sigh and splitting
gourd
Against the cruel drawing board,
Erasing this, erasing that—
And losing pounds of costly fat!

And then the checker's heartless
stabs!—
The danged blue pencil's misfit dabs
On figures o'er which we had stewed
In hopes the eagle-visioned dude
Would pass them by as all O.K.!
But no such good luck, sad to say.

When we look back upon those times
Before lop-sided, bughouse rhymes
Arrived to turn "Eds'" sconces gray,
As they peruse them day by day,
We sometimes wish they'd come
again—
Though then we worked hard for our
yen!

* * *

Is That So!

"The action taken by the American Railway Engineering Association in adopting specifications embodying the application of a water-cement ratio as the criterion for proportioning concrete is a further evidence that the railroads are retaining a leadership which they have exercised throughout the history of the modern use of concrete, for the recent action by the Association is in large measure an official endorsement of what has become an accepted practice on the part of a considerable number of the railroads."—Editorial in *Railway Age*.

* * *

Two More

(218) *Engineer of Good Taste*—The title of a young lady in the furniture department of the Macy store at Atlanta, Ga.

(219) *Progress Engineers and Zodiac Readers*—"Know thyself and others best by astrology's methods," says their card. They live in Los Angeles.

Engineering Societies

Calendar

Annual Meetings

ASSOCIATED PENNSYLVANIA CONSTRUCTORS, Harrisburg, Pa.; Annual Meeting, Harrisburg, March 24, afternoon, and March 25, 1927.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Spring Meeting, Asheville, N. C., April 20-22, 1927.

AMERICAN WELDING SOCIETY, New York; Annual meeting, New York City, April 27-29.

NATIONAL CONFERENCE ON CITY PLANNING, New York City; Annual Meeting, Washington, D. C., May 9-11, 1927.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Chicago, Ill., May 9-12, 1927.

CONFERENCE OF STATE SANITARY ENGINEERS, Washington, D. C.; Annual Meeting, Chicago, Ill., June 4-6, 1927.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Tulsa, Okla., June 6-8, 1927.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Meeting, Chicago, Ill., June 6 to 11, 1927.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, French Lick, Ind., June 20-24, 1927.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, New York City; Annual Meeting, Orono, Maine, June 27-30, 1927.

The Society of Engineers of the San Francisco Bay Region at its March 8 meeting had two interesting addresses: one on offshore location by means of hydrophones and radio transmission, by Commander Thomas J. Maher of the U. S. Coast and Geodetic Survey ship "Guide"; and the other by Charles J. Ullrich, of Salt Lake City, president of the American Association of Engineers, on the Colorado River development and situation from the standpoint of the "upper basin" interests.

The Western Society of Engineers lists papers for coming meetings as follows: "European Ports and Harbors," Major Rufus W. Putnam, March 28. "Industrial Gas Uses," W. A. Darrah, April 4. "Chicago Foundation Problems," R. C. Smith, April 11. "Public Protection at Railway Grade Crossings," Robert H. Ford, assistant chief engineer, C., R. I. & P. Ry., April 25.

Obituary

WILLIS P. KIMBLE, assistant engineer for the Chicago & Erie R.R., with headquarters at Marion, Ohio, died March 8, 1927, aged 69 years. He was graduated from the University of Illinois as a civil engineer in 1879, and the same year began working for the Atchison, Topeka & Santa Fe R.R. in the vicinity of Las Vegas, N. M. Mr. Kimble was a member of the first party of engineers to make a railroad survey from the United States into Mexico, and also to make the first map of Paso del Norte, a town then over 300 years old. He died at Los Augets, Cal., while on a leave of absence.

DONALD F. MCLEOD, professor of municipal engineering at the University of Mississippi, died at his home in Oxford, Miss., March 12, aged 54 years. Mr. McLeod was born in Nova Scotia and educated first in a school there; he graduated in 1907 from Cornell University in civil engineering. For a year he was professor of civil engineering at Clarkson College of Technology. Then he began a period of service at Ithaca, N. Y., as chief engineer of the board of public works and superintendent of public works, and later was consulted on the development of water supply for Ithaca. He was also city engineer of New Glasgow, N. S., city engineer of Lakeland, Fla., and professor of municipal engineering at the University of Mississippi.

PATRICIUS MCMANUS, president of P. McManus, Inc., Philadelphia, Pa., a railroad contractor and an engineer, died March 2 at his home in Philadelphia, at the age of 78 years. Among other railroad construction jobs, Mr. McManus laid the original track system into the Broad St. Station in Philadelphia, and the subway tracks on Market St., and constructed the track system over Hell Gate bridge at New York City for the New York Central R.R. In recent years the firm was a general contractor for the Pennsylvania and Reading railroads.

Personal Notes

W. L. LOSE, engineer and contractor with offices in Tonawanda, N. Y., has established offices at 500 Brisbane Building, Buffalo, N. Y. The firm will be known as the Louck Construction Co., Inc.

HARRY RANDALL, for many years division superintendent of the Canadian Pacific R.R., has been appointed chief engineer of the Pacific Great Western R.R.

FRANK A. KATTMAN, formerly county surveyor of Clay County, Indiana, was recently elected again city engineer of Brazil, Ind. The city has been without a city engineer for two years, since Mr. Kattman's first term.

GEORGE R. WIEGHARDT has been appointed water engineer for the city of Baltimore, Md. For the past two years Mr. Wieghardt had been techical advisor and business manager of Baltimore's Department of Education. He is a graduate in civil engineering of Cornell University and has had a varied engineering experience—in the Bureau of Sewers at Baltimore, on hydro-electric work for J. G. White & Co., resident engineer for the Baltimore water department on the design and construction of the Montebello filtration plant. After that plant was completed, he was engaged on examination of water supplies and construction of dams under the jurisdiction of the Pennsylvania Water Supply Commission. From 1916 to 1918 he served as deputy water engineer of Baltimore, then joined the city's highway department. As a member of the Board of Estimate and president of the Board of Public Improvements he had charge of all engineering work in the city except water and harbor works. On change of administration in 1920 he resigned from city work and carried on private practice to 1924 when he was appointed to the Baltimore Department of Education position.

EDWARD C. MURPHY, for many years a hydrographic engineer in the Water Resources Branch of the U. S. Geological Survey, has retired from active work in that position, being the first engineer in that branch to be so retired. Mr. Murphy graduated from Cornell University in 1884 and later was given two further degrees from the university. After some years of teaching at Cornell and at the University of Kansas, he joined the U. S. Geological Survey in 1892 and served it continuously on hydrographic work, special investigations and on the accuracy of stream measurement by use of current meters. In 1906 he went to California to assist in studies on the carrying powers of rivers. In later years he has been assigned to studies of water power and irrigation in relation to the classification of public lands. He lives in Berkeley, Calif.

DON C. ESTES, until recently a concrete designer for the American System of Reinforcing at Milwaukee, Wis., has joined the St. Louis office staff of the Portland Cement Association as structural engineer. For five years after graduating in 1921 from Cornell University, Mr. Estes was a bridge designer and resident engineer on a large bridge project for the Illinois Division of Highways.

LANGFORD T. ALDEN, Vancouver, B. C., has entered consulting engineering practice in that city. A graduate of Rensselaer Polytechnic in 1909, Mr. Alden has had a varied experience in railroad, bridge, structural, and oil refinery work and for some time has been specializing in harbor engineering. He served for three years in the French army during the War, and has been decorated by the French government. His work has carried him to Mexico, Japan, Canada and in many sections of the United States.

B. S. MERRILL announces that he has resigned his membership in Favrot & Livaudais, Ltd., New Orleans, La., of which firm he has been chief engineer, and will practice as consulting engineer specializing in the design of foundations and reinforced-concrete, structural steel and timber structures, as well as estimates, investigations and reports on building construction. His office will be in the Hibernia Bank Building, New Orleans.

H. S. KERR, who has been acting chief engineer of the Utah State Highway Department since the death of Ira K. Browning, chief engineer, has now been appointed chief engineer for the department. Mr. Kerr has been in the department since 1921, previous to which he had done considerable railway and highway work in the West.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer is Doing for the Engineer and Contractor

Motor Truck Manufacturers Organize in Chicago

The Motor Truck Association of Chicago was organized March 1 as a culmination of the efforts that a number of the manufacturers and distributors in the Chicago territory have been putting forth for the past several months. It is the purpose of the association first to promote and encourage practical and sane policies governing the sale, service and use of motor trucks in the Chicago territory; second, to promote and encourage those influences that will protect and assist the business of motor truck transportation; and third, to discourage practices by manufacturers and distributors and those engaged in motor truck transportation that are in any way injurious.

Some of the matters of vital interest with which the association will be concerned are:

The opportunity for better understanding and closer co-operation between members; the opportunity for credit and service managers of different organizations to discuss their various problems and benefit by experience of others; the opportunity for uniformity in securing information on applicants for motor truck purchases and a more conservative basis for extension of credit; the possibility for closer co-operation with allied interests, including those engaged in motor truck operation for hire or for individual use; the possibility of eliminating the abuses in motor truck operation from various causes; and the possibility of eliminating a number of practices and demands upon the motor truck industry that are neither economical nor beneficial.

The following officers and directors were elected: president, S. M. Williams, manager, Autocar Sales & Service Co.; vice-president John Nicols, manager, General Motor Truck Co.; treasurer, O. E. McCarthy, manager, Pierce-Arrow Truck Co. Directors were elected as follows: J. D. Connell, manager truck department, Reo Motor Car Co.; R. M. Cutting, president, Chicago Truck Co.; N. N. Griffin, vice-president, International Motor Co.; Robert Hendrickson, sales manager, Hendrickson Truck Co.; K. B. Harwood, manager, truck department, Dashiell Motor Co.; O. E. Pederson, manager, Federal Motor Truck Sales Corp.; H. E. Senour, manager, the White Co.; and W. F. Wittenberg, manager, Sterling Co.

Wood Utilization Committee to Meet in May

The annual meeting of the National Committee on Wood Utilization is scheduled for May 3 at the Department of Commerce, Washington, D. C., according to an announcement by Herbert Hoover, chairman of the committee. The purpose of the meeting is to adopt the most effective wood utilization program for the next fiscal year to guide the national committee in its work. It is planned by Axel H. Oxholm, director of the committee, that business may be completed in one day, so that the following day may be available for special meetings of the various project committees.

Intermediate Grade Billet Steel Now Only Reinforcing Standard

The current intermediate grade of the American Society for Testing Materials was adopted as the single standard grade of new billet stock for concrete reinforcement at a general conference held under the auspices of the National Committee on Metals Utilization on Saturday, March 19, 1927. The conference was attended by 50 representatives of manufacturers, distributors, consumers and engineers interested in steel reinforcement for concrete.

A. E. Lindau, chairman of the Grade of Steel Committee which has been conducting the survey of current practice during the past year, presented the committee's report. It was the sense of the meeting that a single grade of new billet stock was desirable for concrete reinforcement. The discussion that followed developed that the majority of demand of the country was concentrated in the intermediate grade. For this reason the conference adopted this grade as standard for a period of one year at the end of which time a similar general conference will be held to discuss the success of the program.

W. C. Wetherill, director of the National Committee on Metal Utilization, was authorized to appoint a steering committee, made up of representatives of all interests to sponsor the project. This committee is to co-operate as far as possible with the American Society for Testing Materials.

National Committee on Metals Utilization: W. Chattin Wetherill, E. W. Ely, Joseph S. Crews, P. H. H. Dunn.

Cement Company to Build New Mill in Maine

The Lawrence Cement Co., of Northampton, Pa., manufacturer of Dragon portland cement, is to expand its production and distribution facilities by the establishment of a new cement mill at Thomaston, a few miles from Rockland, Me. The new mill, for which plans and specifications are being prepared by the Burrell Engineering & Construction Co., Chicago, will cost about $2,000,000 and will have a production capacity of about 2,500 bbl. per day. It is expected to complete the new mill by next January. Land for the mill was purchased last month from the New England Portland Cement & Lime Co. The Lawrence company has already taken over the operation of an existing lime plant on the site producing a product under the trade name "Mainroc." In addition to the new cement mill, a new lime-grinding plant will be erected.

At its existing plant in Pennsylvania, the Lawrence Cement Co. has a producing capacity of about 7,400 bbl. a day, which will be supplemented by a production of 2,500 bbl. a day when the new mill in Maine is completed.

Concrete Road Yardage

For February the square yardage included in concrete pavement contract awards according to the Portland Cement Association were: 2,336,031 for roads; 1,935,262 for streets; and 119,382 for alleys; or a total for the month of 4,390,675 sq.yd.

The accompanying table summarizes the statistics for the current year:

SQUARE YARDS OF CONCRETE PAVEMENT AWARDED DURING 1927

Month	Roads	Streets	Alleys	Total All Classes
Jan.	2,656,118	1,504,059	75,352	4,235,529
Feb.	2,336,031	1,935,262	119,382	4,390,675
Totals	4,992,149	3,439,321	194,734	8,626,204

Barrett Co. Wins Claim from U. S.

The Barrett Co. is entitled to recover from the United States the cost of constructing and equipping a plant at Frankford, Pa., for the distillation of xylol during the war, the United States Supreme Court held Feb. 21 in a decision by Chief Justice Taft which reversed a decision by the Court of Claims. The company erected the plant under contract that the government was to furnish the funds, all of the product being for the use of the navy and the xylol to be distilled and refined from special solvent naptha furnished by the government. The estimate of cost was $253,321 and this amount was paid by the government. The total expense at the time of the armistice however had reached $337,780, due to increasing labor costs and changes in design made with the knowledge of the government even if not with its specific consent. The plant was not completed when the armistice was signed and the contract was cancelled. Subsequently, the company purchased the plant from the government for $110,000. The company sued for $84,459, the difference between the estimated cost of the plant and the actual cost. The Court of Claims held that it was not entitled to this sum. The Supreme Court reversed this decision and remanded the case to the Court of Claims for adjustment.

Business Notes

DRAVO EQUIPMENT CO., Pittsburgh, has been appointed by the Ree Corporation, 110 West 40th St., New York, to take charge of the entire national distribution of the Ahlers concrete strength regulator. The device is designed for attachment to concrete mixers for the control of the water-cement ratio. It was designed and developed

on a practical construction job scale by John G. Ahlers, president of the Barney-Ahlers Construction Corporation, New York. Mr. Ahlers is planning a trip abroad this summer to make arrangements for the foreign distribution of his concrete strength regulator. The manufacture of the device will be continued by the Ree Corporation, with Mr. Ahlers as president, while all matters connected with distribution and sales will be in the hands of the Dravo Equipment Co.

MONARCH TRACTORS CORP., Springfield, Ill., has made two new distributor appointments: Weber Implement & Automobile Co. for both St. Louis and Kansas City., and the E. F. Craven Co. at Greensboro, N. C.

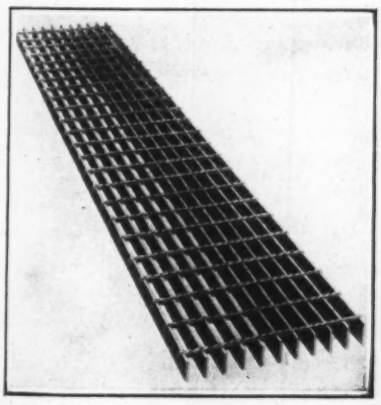
ROY D. CHAPIN, chairman of the board of the Hudson Motor Car Co. has been made president of the National Automobile Chamber of Commerce to succeed COL. CHARLES CLIFTON, who has resigned after a quarter of a century's work as the association's head. Alvan Macauley, president of Packard, was elected vice-president and Alfred H. Swayne, vice-president of General Motors Corporation, vice-president of the passenger car division.

ARTHUR KELLER, chief electrical engineer Harnischfeger Corp., Milwaukee, died at his home in Milwaukee March 12. He was born in Switzerland in 1882 and has been connected with the Harnischfeger Corp. for the past twenty years. Mr. Keller was a member of the American Institute of Electrical Engineers and of the Association of Iron and Steel Electrical Engineers.

New Developments

Grating of Welded Construction Has Many Advantages

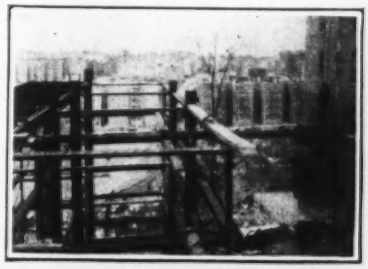
A new design in steel grating and flooring has been developed by the Blaw-Knox Co., Pittsburgh, Pa., which, in addition to other advantages, is claimed to have unusual strength and a strictly non-slip surface. It is made of longitudinal bars, eleven to the foot, and twisted crossbars on top of these spaced on 2½-in. centers. Longitudinal bars are ¼ in. to ⅜ in. thick as required, while the crossbars have a sufficient section to properly brace the longitudinal bars. Other advantages of this new grating are that it is self-cleaning, presents an ideal surface for galvanizing or painting, has an attractive appearance and affords maximum lighting efficiency.

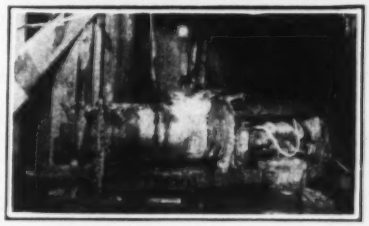


Probably the most important characteristic claimed for it is its method of construction and consequent strength. It is made by means of a resistant welding process which forges the longitudinal and crossbars into one-piece construction. The twisted crossbars are slightly raised above the level of the longitudinal bars, so that the foot is at all times in contact with the non-slip surface. A simple method is provided for fastening this grating from the top so that it is not necessary to use a scaffold or ladder in placing or removing a section.

Concrete Placed Vertically to 105 Ft. Above Mixing Point

A test of pneumatic placing of concrete in a vertical direction was made on the Fort Washington Avenue section of the new subway in New York on March 2. At the point chosen for the test the subway is in tunnel about 135 ft. below the street level and an elevator shaft from the subway up to the street provided a convenient place for setting a long vertical pipe. A Ransome pneumatic concrete placer of the horizontal type was set up at the bottom of the shaft and connected with a 6-in. riser pipe extending up through the steel framework in the shaft to an elevation of 105 ft. above the placer. The upper end of the pipe was turned at right angle out of the shaft where it discharged into an open bucket. The concrete placer and the upper portion of the pipe with concrete discharging into the bucket are shown in the accompanying illustration.



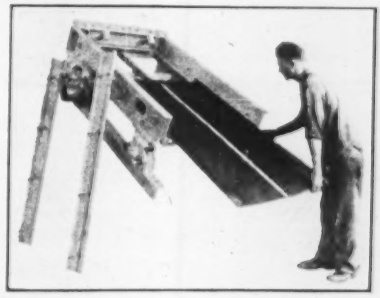


The concrete was mixed in 7 cu.ft. batches of a normal consistency. At the beginning of the test air pressure in the feed line stood at 90 lb. and during the operation of the test it ranged between 50 and 60 lb. Each test took about 40 seconds and the concrete came out of the upper end of the pipe in surges rather than in one continuous stream. The actual time required to shoot the concrete out of the placer and through the pipe was 15 seconds.

It is not the intention to use this method of placing concrete at the point where the test was made, the test being made primarily to determine whether concrete can be placed pneumatically through such a great vertical distance.

Ball Bearing Vibrating Screen Is of Simple Construction

A new ball bearing vibrating screen has been announced by the Link-Belt Co., Chicago, which is claimed to possess adaptability to almost any fine screening work. The operating mechanism is very simple, consisting of a single shaft riding in oversized ball bearings. The shaft is thrown out of balance by adjustable counterweights and imparts vibrations to the screen box on which it is mounted. This screen box carries the screen cloth which is secured, under tension, by means of adjustable side clamps. There are five standard sizes—2x5 ft.; 3x5 ft.; 4x5 ft.; 3x8 ft.; and 4x8 ft. The feed hopper attached to the receiving end of the screen box vibrates with it which is claimed to uniformly spread the material over the screening surface.



New 1-Yd. Convertible Shovel Uses Diesel Power Plant

A 1-yd. Diesel shovel, convertible to dragline, clamshell and crane, is the most recent development of the Bucyrus Co., Milwaukee, Wis. Lower fuel, yardage and upkeep costs, together with increased power, are said to have been the guiding principles in the construction of this model, known as the D-2. The power plant is a four-cycle full-Diesel engine with a mechanical feed eliminating the use of an air compressor. It is claimed that the engine can be started from stone cold to full load in 20 sec., no priming and preheating being necessary. A special center pintle construction relieves the

vertical propelling shaft of all digging strains and keeps the revolving frame centered on the base frame. A patented rope crowd permits crowding and hoisting operations to take place individually as well as simultaneously. The new straight boom of this shovel is claimed to have all the advantages of the company's bent boom, with the added advantages that the machine operates better when the boom is at low angles. Also, because of this lightweight box girder boom less counterweight is required at the rear of the shovel.

Manufacturers and Trade Associations

Calendar

Annual Meetings

HYDRAULIC SOCIETY, New York; Annual meeting Chicago, March 25, 1927.

AMERICAN WELDING SOCIETY, New York; Annual meeting, New York, April 27-29.

NATIONAL LUMBER MFGRS. ASSOCIATION, Washington, D. C.; Annual meeting, Chicago, April 28-29.

NATIONAL LIME MANUFACTURERS' ASSOCIATION, Chicago; Annual meeting Chicago, April 28-29.

WATERWORKS MANUFACTURERS ASSOCIATION, New York; Annual meeting, Chicago, June 6-10.

New Publications

Gasoline Hoists — LIDGERWOOD MFG. CO., New York City, in its new bulletin No. 8, lists its complete line of gasoline hoists, giving illustrations and complete tabular matter.

Roofs for Oil Tanks — CHICAGO BRIDGE & IRON WORKS, Chicago, has prepared a 22-page pamphlet on the Wiggins floating roof for oil-storage tanks, a special feature of which is a gas-tight seal which prevents evaporation. Drainage of the roof is provided by a sump and hose. Several improvements in details are described. There are statements of tests of stability, evaporation and fire protection.

Dredging Equipment — MORRIS MACHINE WORKS, Baldwinsville, N. Y., has just issued a 55-p. bulletin, No. 125, entitled "Sand & Dredging Pumps, Hydraulic Dredge Machinery." Besides containing illustrations, specifications and descriptions of the company's pumps, dredges and dredging equipment, the catalog includes a discussion of hydraulic dredging, its history, development and present stage of perfection. Sand and gravel production, hydraulic methods in mining, dredging and sand pumps in general contracting work, and hydraulic conveying in industrial plants are some of the subjects discussed.

Business Side of Construction

Facts and Events that Affect Cost and Volume

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, religious and other buildings. Under the head of excavations are included drainage, irrigation, levee, river and harbor projects.

Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
Mar. 24, 1927	$21,013,000	$56,125,000	$77,138,000
Mar. 17, 1927	18,834,000	25,403,000	44,237,000
Mar. 25, 1926	17,776,000	28,126,000	45,902,000
Heaviest Week			
1927, Mar. 10	27,407,000	54,796,000	82,203,000
1926, Mar. 11	13,029,000	73,613,000	86,642,000
1925, Sept. 3	16,215,000	69,424,000	85,639,000
Jan. 1 to Date			
1927	190,060,000	419,057,000	609,117,000
1926	199,977,000	401,022,000	600,999,000

Materials Demand Slower Than at This Time Last Year

Improvement in Brick Supply and Demand and Increased Cement Shipments Furnish Exceptions to General Trend

A SLIGHT recession in demand is noted in the principal construction materials, when latest available data are compared with figures of a year ago.

Steel and lumber appear to be more adversely affected than either cement or brick.

The February steel ingot output, for the nation as a whole, is below that of the corresponding period last year. Steel demand, as indicated by unfilled tonnage is considerably under the February 28, 1926, level.

Cement production shows a slight seasonal decline, while shipments register the usual upturn characteristic of the particular period of the year under consideration.

The lumber movement is slower throughout, cutting having slowed down to a point consistent with the lessened volume of demand.

Brick orders and also the quantity available at plants throughout the country, show marked improvement over conditions as of Feb. 1, 1926.

Steel ingot figures are from the American Iron and Steel Institute; unfilled steel orders are those on books of the U. S. Steel Corporation; cement statistics come from the Bureau of Mines; lumber data are drawn from bulletins of the National Lumber Manufacturers Assoc.; and the brick situation is from the report of the Common Brick Manufacturers Assoc. of America.

PRODUCTION AND DEMAND IN FOUR IMPORTANT CONSTRUCTION MATERIALS

			Per Cent Gain (+) or Loss (—) Compared with 1926
Steel ingot output	(Feb., 1927) 3,725,577 tons	(Feb., 1926) 3,801,776 tons	— 3
Steel, unfilled tonnage	(Feb. 28, 1927) 3,597,119 tons	(Feb. 28, 1926) 4,616,822 tons	—24
Cement production	(Feb., 1927) 7,368,000 bbl.	(Feb., 1926) 7,731,000 bbl.	— 5
Cement shipments	(Feb., 1927) 6,726,000 bbl.	(Feb., 1926) 5,820,000 bbl.	+16
Lumber production	(Feb., 1927) 787,801,000 ft.	(Feb., 1926) 902,476,000 ft.	—13
Lumber orders	(Feb., 1927) 822,047,000 ft.	(Feb., 1926) 975,954,000 ft.	—16
Brick, burned at yards	(Feb. 1, 1927) 462,565,000	(Feb. 1, 1926) 324,203,000	+43
Brick orders	(Feb. 1, 1927) 324,837,000	(Feb. 1, 1926) 259,158,000	+25

Unit Prices Bid On Materials And Operations in Public Road Work

COSTS of structural concrete and reinforcing steel in place, surfacing, excavating, haulage, and common labor are included in the following tabulation.

Thirty-three county road projects in eight states were selected at random from the 1926 lettings.

The jobs cover concrete, earth, gravel, sand-clay, and rock asphalt surfacings, together with bridge work, culverts, grading and draining, etc.

Common labor rates ranged from 25 to 50c., with the average around 36c. per hour. Average haul was 2.4 miles.

BID PRICES, BUREAU OF PUBLIC ROADS, U. S. DEPARTMENT OF AGRICULTURE

County	Contract Let to	Type	Width of Surfacing, Ft.	Unit Prices Bid—Materials in Place: Surfacing Sq. Yds.	Surfacing Unit Price	Excavation Cu. Yds.	Excavation Unit Price	Structural Concrete 1-2-4 Cu. Yds.	Structural Concrete 1-2-4 Unit Price	Steel Reinforcing Lbs.	Steel Reinforcing Unit Price	Average Haul, Mi.	Average Hourly Wage, Common Labor
IOWA													
Appanoose	Keokuk Quarry and Const. Co., Keokuk, Iowa	Concrete	18	.....	.....	40,158	$0.38	75,318	$2.37	.....	.....	2	$0.35
KANSAS													
Marshall	Wayland Bridge Co., Washington, Kans.	Earth	..	.....	.....	15,670	.30	76	20.00	6,540	$0.05	2½	.35
Marshall	O'Hagen & McVicar, Kansas City, Mo.	Bridge No. 1	..	.....	.....	200	.90	205	18.90	18,307	.05	2½	.35
Marshall	O'Hagen & McVicar, Kansas City, Mo.	Bridge No. 2	..	.....	.....	100	.90	154	18.90	7,195	.05	2½	.35
Marshall	Wayland Bridge Co., Washington, Kans.	Earth	..	.....	.....	17,401	.30	59	20.00	4,860	.05	3	.35
Marshall	Fairbury Const. Co., Fairbury, Neb.	Bridge No. 1	..	.....	.....	350	.90	.....	.....	27,478	.05	3	.35
Marshall	A. L. Cook, Ottawa, Kans.	Earth	..	.....	.....	19,234 3,701	.44 1.50*	104	20.00	8,655	.05	1½	.35
Marshall	A. L. Cook, Ottawa, Kans.	Bridge No. 1	..	.....	.....	81 53	2.00 5.00*	472	18.50	12,537	.05	1½	.35
Saline	Yancey Const. Co., Abilene, Kans.	Bridges and Earth	..	.....	.....	.....	.....	656	18.00	63,283 335,061	.05 .64†	3	.40
Saline	A. L. Cook, Ottawa, Kansas	Earthwork&Culverts	..	.....	.....	118,819	0.21	461	19.00	39,699	0.055	3	.40
Butler	O'Hagen & McVicar Co., Kansas City, Mo.	Earth	..	.....	.....	35,244 2,364	.31 1.80*	344 59	21.00 21.00‡	29,935	.055	3	.50
Marshall	O'Hagen & McVicar, Kansas City, Mo.	Bridge No. 1	..	.....	.....	640 150	.80 2.50*	889	17.50	32,677	.055	2½	.35
Marshall	O'Hagen & McVicar, Kansas City Mo.	Earth	..	.....	.....	6,594	.29	29	20.00	2,520	.05	2½	.35
Cherokee	Tibbets & Tibbets, Kansas City, Mo.	Gravel	..	.....	.....	80,679 508	.27 2.00*	415	20.00	36,054	.05	4	.40
Johnson	Tibbets & Tibbets, Kansas City, Mo.	Concrete	..	56,484	$2.00	32,139 97	.32 1.80*	618	18.00	54,761	.045	2	.35
Barber	Shultz Const. Co., Independence, Kans.	Sand Clay	..	9,839	.45	33,565	.29	180	20.00	16,360	.05	2	.35
MICHIGAN													
Kent	P. W. O'Connor, Grand Rapids	Concrete	..	18,905	.95	32,177	.48	.....	.....	.....	.....	0.8	.50
NEBRASKA													
Douglas	Metz Const. Co., Springfield, Nebr.	Concrete	..	11,079	2.38	1,000	.40	9	18.00	786	.06	1½	.40
TENNESSEE													
Shelby	Hays Const. Co., Jackson, Tenn.	Concrete	..	41,771	2.17	.....	.....	.....	.....	.....	.....	1½	.25
Davidson	Foster & Creighton Co., Nashville, Tenn.	Concrete	20	73,389	2.35	34,901 3,005	.60 1.75*	481	22.00	.....	.....	3½	.25
Davidson	S. M. Billiter, Cincinnati, Ohio	Rock Asph.	..	26,409	2.53	26,409 5,156	.550 1.00*	246	22.00	26,352	.06	1½	.25
Campbell	Shea Bros., Knoxville, Tenn.	G. & D.	..	.....	.....	50,990 54,292	.40 .90*	509	22.00	60,616	.06	1½	.25
WISCONSIN													
Milwaukee	L. C. Christianson, Cambridge, Wis.	Concrete	..	11,222	1.89	3,742	.58	.....	.....	510	.06†	½	.50
WYOMING													
Big Horn	Basin Const. Co., Basin, Wyo.	Gravel	18	7,400	1.40	29,140 50	.18 .50*	136	28.00	.....	.....	3	.40
Big Horn	Taggard Const. Co., Lovell, Wyo.	Gravel	..	.....	.....	13,360	.26	.....	.....	.....	.....	3	.40
Big Horn	Taggard Const. Co., Lovell, Wyo.	Gravel	..	.....	.....	.....	.....	116	24.50	12,400	.07	3	.40
Weston	Bagley Bros., Wheatland, Wyo.	Gravel	..	.....	.....	106,500 5,500	.195 1.20*	177	26.00	.....	.....	...	....
Lincoln	Taggard Const. Co., Lovell, Wyo.	Gravel	..	.....	.....	84,000 17,500	.23 1.10*	.....	.....	.....	.....	3	.45
Johnson	W. D. Roscoe, Billings, Mont.	Gravel	..	.....	.....	.....	.....	60	27.50	6,400 38,400	.075 .09†	...	.40
ALABAMA													
Marengo	R. L. Keenan, Selma, Alabama	.....	..	.....	.....	87,992 4,006	.35 .70*	482	25.00	46,994	.06	4	.25
Marengo	Jere Gwin, Birmingham, Ala.	Gravel	16	28,537	.31	.....	.....	.....	.....	.....	.....	...	....
Etowah	S. C. Taylor, Wilsonville, Ala.	Bit. Mac.	18	125,270	1.40	107,672 57,394	.34 .90*	761	25.00	73,250	.05	3	.25
Etowah	S. C. Taylor, Wilsonville, Ala.	Bridges	..	.....	.....	.....	.....	748	25.00	128,170	.05	3	.25

*Rock excavation. †Structural steel. ‡1-3-6.

Weekly Construction Market

A FAIRLY heavy volume of spring construction demand fails to swing the price trend, in the basic materials, away from the steady downward direction taken in November, 1926. Brick is about the only material showing any resistance to the generally declining tendency. In fact, New York City, one of the most important brick consuming centers in the country, showed a decline of about $1 per M. not more than a week ago.

Aside from the situation as expressed in money value of contracts let this week (see table on p. 508) the increasing demand for large structures and bridges is best shown by fabricated structural steel shipments, as reported by the principal fabricators of the country. These are beginning to register substantial increases in volume after a protracted decline, dating back to October, 1926.

The price of structural steel is 29 per cent above its 1913 level, according to latest data available from the Department of Labor. The foregoing refers to an average for the principal producing centers of the country. The following percentages show the approximate rise, compared with the 1913 base, in the basic construction materials: steel, 29; lumber, 80; brick, 108; materials other than the three mentioned, 55; all building materials as a group, 68.

Prices of general commodities sold at wholesale, are 46 per cent above the 1913 level; representing a decline of not more than half a point, compared with the market prevailing at the beginning of the current year.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb	$3.34	$3.80	$4.15	$3.10	$3.35	$3.87½	$3.00	$3.15	$3.80
Structural rivets, 100 lb	4.20	3.80	4.75	3.50	3.75	4.65	5.00	4.00	....
Reinforcing bars, ¾ in. up, 100 lb	3.24	2.80	2.75	2.30@2.50	2.87½	3.87½	2.95	3.10	3.57
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	54%	51%	54.25%	41%	42@53.8%	45%	37.83
Cast-iron pipe, 6 in. and over, ton	47.60	42.75	—54.00	46.20	48.50	62.00	47.00	55.00	62.50
Concreting Material									
Cement without bags, bbl	2.35@2.50	2.35	2.05	2.05	2.22	2.85	2.31	2.65	1.15
Gravel, ¾ in., cu.yd	1.75	1.90	2.38	1.85	1.65	1.90	1.80	1.25	1.90
Sand, cu.yd	1.00	1.60	2.00	1.65	1.25	1.00	1.40	1.25	1.35
Crushed stone, ¾ in., cu.yd	1.94	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	61@63	34.00	56.00	40.50	38.75	33.25	27.00	25.00	50.00
Lime, finishing, hydrated, ton	18.20	22.50	19.00	20.00	25.50	24.00	25.50	24.00	21.00
Lime, common, lump, per bbl	2.10@3.00	1.50	1.82	1.50	1.70	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	20.40	12.00	14.10	12.00	13.75	9@10	15.00	15.00	+21.25
Hollow building tile, 4x12x12, per block	Not used	.0895	.112	.076	.072	.085	.....	.09	.10
Hollow partition tile 4x12x12, per block	.1112	.0895	.112	.076	.072	.085	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal	.81¾	.90¾	1.10	.80	.93¾	+1.04	—.89	1.12	+1.05
Common Labor									
Common labor, union, hour	.90½	.30	.....	.90	.....	.50@.55	.60	.62½	....
Common labor, non-union, hour	.....	.25	.30@.50	.....	.45@.60	.40@.45	50	.....	25@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. L.c.l. is less than carload lots.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Reinforcing bars (billet steel) and shapes delivered to job in less-than-carload lots.

Labor — Cement and concrete laborers' rate, $1.06¼; building laborers, 90½c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine. Reinforcing bars (billet steel) f.o.b. warehouse in carload lots; shapes, less-than-carload lots.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Bars (billet steel) at warehouse in carload lots; shapes, less-than-carload lots.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Mar. 3, the next on Apr. 7.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, l.c.l.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Dallas quotes lime per 180-lb. bbl. Cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. Bars (billet steel) carlots; shapes, l.c.l.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Bars (billet steel) and shapes, less-than-carload lots.

Montreal quotes on fir lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 99.96). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83. Bars (billet steel) and shapes, in carload lots.

Unit Prices

For actual prices bid on materials in place at various construction jobs throughout the country, see p. 196 of this issue, following Construction News.

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For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month